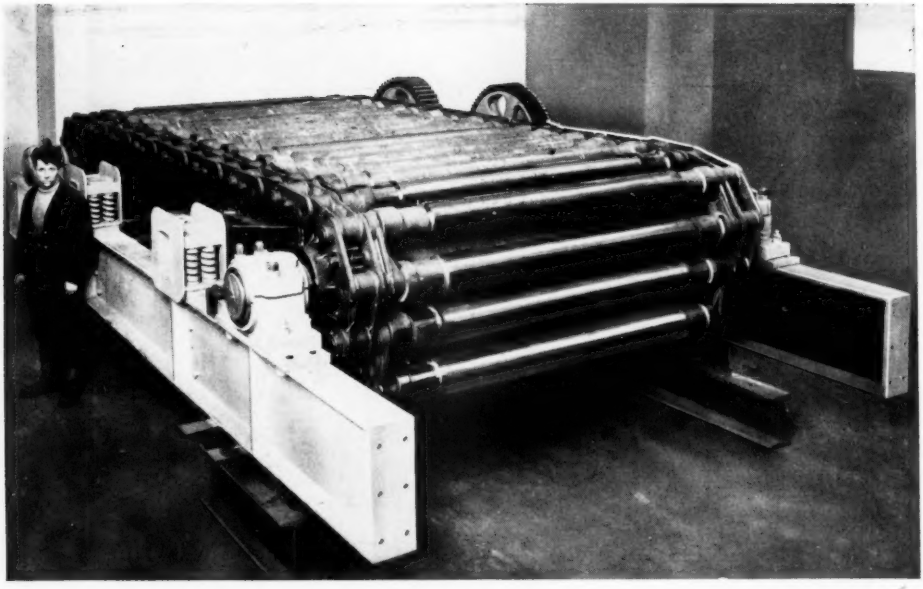
November, 1959

The Mining Magazine

VOL. 101 . No. 5. LONDON. PRICE : 3s. ; With postage 3s. 8d.



Ross Drop-Bar Feeder for Kneeshaw Lupton & Co. Ltd., Llanddulas Quarries, North Wales

Photograph shows a No. 10 Patent Ross Drop-Bar Feeder on shop assembly before despatch to Kneeshaw Lupton & Co. Ltd., for feeding a 60″ x 42″ jaw crusher at their Llanddulas Quarries. The photograph illustrates the very heavy construction of the apron, in this case 7″ dia. steel bars at 10″ centres, and the heavy shock absorbing coil springs which support the apron.

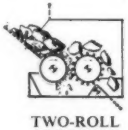
ROSS ENGINEERS LIMITED, 11 WALPOLE ROAD, SURBITON, SURREY

Telephone: Elmbridge 2345

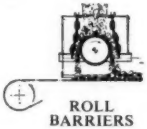
ROSS SCREEN & FEEDER CO., WESTFIELD, NEW JERSEY, U.S.A.

CHAIN FEEDERS

DROP-BAR FEEDERS



TWO-ROLL GRIZZLIES



ROLL BARRIERS

CONTINUOUS LOADING VALVES

C3/P

ROSS MATERIAL HANDLING EQUIPMENT

FOR THE IRON & STEEL, MINING AND QUARRYING INDUSTRIES

The Mining Magazine

PUBLISHED on the 15th of each month at SALISBURY HOUSE, LONDON, E.C. 2
for MINING PUBLICATIONS, LTD.

Editor : F. HIGHAM, A.R.S.M., M.Sc., M.I.M.M.

Manager : ST.J. R. C. SHEPHERD, A.R.S.M., D.I.C., F.G.S. *Chairman :* H. E. FERN, O.B.E., J.P.

Telephone : *NATional* 6290. Telegraphic Address : *Oligoclase.* Codes : *McNeill,* both Editions, *& Bentley.*

PRICE 3s. ; with postage 3s. 8d. Annual subscription, including postage, 35s. ; U.S.A., $6.00.

Vol. 101. LONDON, NOVEMBER, 1959. No. 5.

CONTENTS

EDITORIAL

THE report of the International Association for the Exchange of Students for Technical Experience (I.A.E.S.T.E.) for 1959 shows that once again during the summer vacation it was possible to increase the number of students sent and received under its programme. This year 854 students were received and 837 sent, the corresponding figures for 1958 being 829 and 774, respectively. In all 366 British companies co-operated in providing opportunities for overseas students.

IT has now been stated that an exhibition sponsored by the British Chemical Plant Manufacturers' Association is to take place from April 6 to 9, 1960, on the occasion of the International Mineral Processing Congress, 1960. The exhibition, designed to show the many overseas delegates to the Congress the range and scope of British mineral processing equipment, will cover all aspects of the dressing and chemical processing of minerals including coal washing. Organized by Industrial Exhibitions (Services), Ltd., from whom full particulars may be obtained, the exhibition will be open throughout the Congress and will be staged in the two halls which flank the main assembly hall of Church House, Westminster, in which the Congress sessions will be held.

IT was recently announced that Dr. A. Roberts, director of the Postgraduate School in Mining, at the University of Sheffield, is now at the University of Minnesota as Visiting Professor in Mining Engineering for the duration of the current academic year. While in the United States Dr. Roberts is to visit mining centres and university mining schools and to present lectures and course work at the University of Minnesota on mine plant engineering, with some emphasis on his speciality of mine environmental studies. In addition he is to direct the establishment of the mine plant laboratories in the newly-completed School of Mines building at Minneapolis and take part in the direction of graduate students and mining research activities.

A SPECIAL exhibition to remain open for several months has been staged in the Geological Museum, South Kensington. It consists of aerial photographs of mines and quarries which show past and present surface aspects and effects of quarrying and mining in the United Kingdom. Included are views of famous mining areas in Cornwall and the Mendips, first exploited in Roman times or earlier, and of the great modern open excavations and quarries for iron ore, limestone, coal, brick-clay, china-clay, sand and gravel, building stone, road stone, and other raw materials which are an essential part of modern economy. The exhibition illustrates the great variety of useful rocks and minerals found in this country and it is suggested that the special view of the aerial camera, which picks out mines and quarries in sharp contrast to their surroundings, emphasizes the need for careful planning of their extraction, so that disturbance to the land surface may be kept at a minimum and rehabilitation provided whenever possible. The photographs are all from the Cambridge University Collection, an extensive library of air photographs specially selected to meet the needs of teaching and research. They have been taken during recent years by Dr. J. K. St. Joseph, Curator in Aerial Photography at Cambridge, from aircraft of the Royal Air Force on training flights.

THE Minister for Territories in Australia, Mr. Paul Hasluck, recently announced that mineral production in the Northern Territory in 1958–59 (excluding Rum Jungle uranium and building and construction material) was valued at £4,155,000. In spite of the fall in prices of many minerals that figure was second only to the record level of £4,352,000 of 1957–58. The main mineral products were copper (£2,714,000), gold (£1,003,000), uranium, excluding Rum Jungle, (£280,000), and manganese (£14,000). The mining of wolfram and scheelite ores, which were of major importance in recent years, the Minister said, had now virtually ceased but uranium and manganese were coming into prominence. The value of quarrying and building materials at £610,000 was a record. Mr. Hasluck went on to say that the re-opening of the Government battery at Tennant Creek in October last had boosted small-scale mining in that area. During the last twelve months the battery crushed 5,572 tons for a return of 3,822 oz. of bullion.

He also said that at June 30 last 1,149 persons were engaged in mining, prospecting, and quarrying and that mining and prospecting rights in force at that date included 860 mining tenements covering 39 square miles, 44 Authorities to Prospect covering 12,003 square miles, and five petroleum prospecting permits covering 45,713 square miles.

Commemoration Day at Imperial College

The special visitor this year to Imperial College Commemoration Day was Lord Weeks, chairman of the Finance Corporation for Industry and of Vickers Nuclear Engineering, Ltd. In the course of his address to associates and diplomates Lord Weeks suggested that as nations had progressed along the paths of industrialization and independence the scientist had advanced from the " back room " to the seat at the right hand of power and might soon have to take up the reins of leadership. In order to avoid a lowering of academic standards it was obvious, therefore, that teachers in the earlier stages of education would have to learn how to assist greater numbers of young people to attain the requisite levels of development. Irrespective of superficial divisions and discords, said Lord Weeks, there was one great movement at work in all parts of the world—the hunger for growth. The importance of that influence was continuous, for the " old world " had the responsibility not only of assisting the development of younger nations but also of maintaining the impetus of its own scientific and technological research, in the fruits of which the newer nations shared. The most advanced countries of the world had therefore to learn to look outward more and to change their policies from " natural traditions and aspirations to others based on international welfare ", as Sir James Gray had said recently before the British Association for the Advancement of Science. Future industrial leaders would carry such burdens no less than the politicians, for the world environment of growth demanded from British industry more conscious leadership than that exercised—often quite involuntarily—since the middle of last century. They would also be scientists and technologists, so specialized had the techniques of production and methods of management become.

In his report to the gathering the Rector, Sir Patrick Linstead, said that the College was in a state of rude and vigorous health. There were now 2,660 students, including 590 undergraduate freshmen selected from more than 4,000 applicants. New buildings were coming off the production line not a moment too soon, the first part of the new Engineering block having been finished in time for occupation on the first day of the present term. The fine new Physics building in Prince Consort Road was almost completed externally and would come into service during the session. Minor academic races with time, Sir Patrick said, had involved the construction of new laboratories for nuclear technology and for mining and metallurgy, which had been carried out during the summer vacation. Weeks Hall, the first new Hall of Residence in Prince's Gardens, had been built, with a Vickers benefaction, in 12 months ; it had been formally opened by Lord Knollys, chairman of Vickers, on September 30, and occupied at the beginning of term by 62 students.

The opening of Weeks Hall marks the completion of the first stage of the College's scheme for the development of Prince's Gardens as a residential and social precinct. For this purpose properties on the north, east, and south sides of the Gardens were acquired by the College in 1956. Early in 1957, Vickers—as part of their long-term programme of support for education in engineering subjects—offered to provide a number of scholarships for undergraduate apprentices and a benefaction of £150,000 for a new Hall of Residence, in which holders of such awards could live in term-time with other students of the College. That generous offer was gratefully accepted by the College and the Hall was built in the north-east corner of the Gardens. Weeks Hall, as it has been named, was designed by Richard Sheppard, Robson and Partners (the architects for the Prince's Gardens Scheme) and, although conforming to the general plans for the remainder of the area, possesses an identity of its own within the complete development. That identity springs from the fact that it was planned to meet a dual purpose. As well as being a normal College Hall of Residence during the academic year it would also provide the venue in the Easter and Summer vacations for educational and staff conferences of the Vickers organization.

Coal in Bechuanaland

Exploration of the potential coal areas south-west of Palapye in the Bechuanaland Protectorate by the Geological Survey Department has been in progress since 1948. The Department's Mineral Resources Report No. 1, by O. J. van Straten, recently published,[1] gives the first complete account of the Morapule field, first drilled in 1952. Now nine holes have been put down in the area and these have shown that three separate coal zones are present in the Karroo System sediments, of which the basal Morapule seam zone is the economically important coal-bearing horizon. Within this basal coal zone seams up to 18 ft. in thickness occur and in the central portion of the coalfield there is an area of 9·38 sq. miles where there are possibilities of mining coal with calorific values of 11 lb./lb. to 12 lb./lb. and with an ash content of 12·0% to 18% (raw coal) from the basal zone. In this area the total estimated reserves of coal with a calorific value of 11·34 lb./lb. (raw coal) to a depth of 450 ft. are upwards of 150,500,000 tons. Should mining of the full zone be undertaken, the report states, the total reserves of coal down to 450 ft. with calorific values of 10 lb./lb. to 12 lb./lb. are estimated at approximately double that figure.

In his summary to the report the author says the investigation has shown that the better-quality coals are present in the western section of the coalfield at depths between 350 ft. and 450 ft., there being a progressive increase in the quality and maintenance of seam thickness down dip in a westerly direction. It is possible, he thinks, that coals of consistently higher calorific values may be encountered at a deeper level in the extensive area underlain by coal-bearing Karroo strata to the west, which lies outside the area investigated by the Geological Survey Department during the 1957–58 drilling programme. No exposures of the coal-bearing horizons are present in the Morapule area and the shallowest depth of the sub-outcrop of the coals below the ubiquitous cover of Recent Deposits is 110 ft., so that the possibility of open-cast mining does not appear to be good. In the area investigated, should mining be undertaken, it will, the author thinks, have to be confined to the coals of the basal zone where, from the nature of the coal-bearing horizon, considerable amounts of waste will have to be mined and sorted and the coals subjected to a washing process. Adequate water supplies will have to be developed for this purpose as existing supplies are not strong. In this connexion it is pointed out that no detailed groundwater surveys have been carried out to date and the true groundwater potential of the area is not fully known at present.

The Morapule coalfield is situated at a distance of 7½ miles from Palapye siding on the main railway line from the Union of South Africa to the Federation of the Rhodesias and Nyasaland. There are no terrain difficulties in regard to the construction of a loop line from Palapye to the coalfield area and gradients along such a route are gentle.

[1] Lobatsi : Geological Survey. Price 5s.

Royal School of Mines Dinner

The 75th annual dinner of the Royal School of Mines Association, held as previously in the Apothecaries' Hall, took place on November 3 and was as usual a pleasant re-union of past students and their guests which was greatly enjoyed by those present. The chair was taken by Mr. Frank Higham, this year's president, and his principal guests were Mr. Noel Annan, Provost of King's College, Cambridge, and Mr. J. N. V. Duncan, managing director of the Rio Tinto Company.

In a jovial speech Mr. Annan proposed the toast of the Association and in his reply the President was able to refer to the welcome fact that there has been a notable improvement in recent years in both the quality and quantity of the intake of new students into the School. Mr. Higham suggested that while the new men coming along had not perhaps the same inherited traditions of some of the pre-war entrants they were still men of the right quality.

In responding to the toast of the guests Mr. Duncan referred to the growing needs of the mining industry for men of the right calibre in a world where the rapid expansion of populations in the less-advanced countries is going to make increasing demands on mineral producers. Mr. Duncan addressed himself specifically to the two head masters of public schools present among his fellow guests and urged them and their colleagues in that profession to find out for themselves that the mining industry needed their better boys. The physical and intellectual demands imposed on managerial staffs are now such as to make mining a worthy occupation, an occupation for which second-best material would not do.

MONTHLY REVIEW

Introduction.—The strikes in South America and the United States, with industries in Europe making stronger calls for all metals, has resulted in shrinking supplies and consequent price rises. Copper particularly is in brisk demand and other metals remain firm. Although the steel strikers in the U.S.A. have been ordered back to work it is difficult at the time of writing to judge how soon industrial peace will be restored there.

Transvaal.—The output of the Rand mines for September was returned as 1,701,485 oz., making with 36,567 oz. from outside producers a total of 1,738,052 oz. for the month. The number of natives at work in the gold mines at September 30 was given as 371,813, which compares with 377,257 at the end of the previous month.

Elsewhere in this issue our Johannesburg correspondent refers to the details released regarding the two new mines to be established in the Kinross area. UNION CORPORATION, which recently declared the usual 40% interim dividend, is offering its shareholders one share in BRACKEN MINES and LESLIE GOLD MINES for every 10 shares held. WINKELHAAK MINES is also to offer one new share in these mines for every 25 shares held. Bracken Mines is to have a capital of £7,000,000 and Leslie Gold Mines a capital of £8,000,000, each in 10s. shares. Prospecting in the Kinross area—about 65 miles east-south-east of Johannesburg—was started by Union Corporation in 1949. The first company in the area—Winkelhaak—was formed in December, 1955. Winkelhaak is now an established producer, milling having officially commenced in December, 1958, and last month (September) the mine treated 80,000 tons giving a yield per ton of 5·45 dwt. for a working profit of nearly £70,000. The Bracken and Leslie mines are the second and third mines in the area and there is a possibility of a fourth. The payable reef in the Kinross area is the Kimberley Reef.

A circular to shareholders of the SOUTH AFRICAN LAND AND EXPLORATION COMPANY last month states that plans are now ready for opening up the Withok area. It is proposed to put in a new shaft system north of the Vogels tear fault, approximately 10,000 ft. due south of No. 1 shaft, and to increase the pumping capacity of the mine. To date expenditure already incurred on Withok has been met from surplus funds and from amounts drawn on temporary loan facilities granted by the ANGLO AMERICAN CORPORATION OF SOUTH AFRICA. However, the total capital requirements up to the middle of 1963, when it is expected the shaft-sinking and ancillary capital programme will have been completed, are estimated at £3,109,000 and the directors propose to raise £2,000,000 by the issue of unsecured notes in January, 1960, of which £1,980,000 will be offered to shareholders.

The report of WEST DRIEFONTEIN GOLD MINING for the year ended June 30 last shows a profit of £8,459,248, of which dividends equal to 8s. 3d. a share require £2,904,445. In the year 1,021,000 tons of ore was treated and 959,169 oz. of gold and 175,686 lb. of uranium oxide recovered. Ore reserves at June 30 last were estimated as 3,082,000 tons averaging 15·7 dwt. in gold per ton with 0·21 lb. of uranium.

The operations of VENTERSPOST GOLD MINING in the year to June 30 last resulted in a profit of £743,030, of which dividends equal to 1s. 9d. a share absorbed £428,750. In the year 1,537,000 tons of ore was crushed and 381,834 oz. of gold recovered. At June 30 the ore reserves were estimated as 2,256,000 tons averaging 5·7 dwt. in value.

A profit of £2,464,468 was earned by DOORNFONTEIN GOLD MINING in the year ended June 30 last, dividends equal to 3s. a share requiring £1,474,200. The 1,064,000 tons of ore milled in the year yielded 441,274 oz. of gold and 106,093 lb. of uranium oxide. Ore reserves at June 30 last were estimated to be 2,651,000 tons averaging 7·4 dwt. in gold and 0·17 lb. of uranium per ton.

The accounts of SUB NIGEL for the year to June 30 last show a profit of £351,417, of which £132,890 was transferred to reserve against an initial repayment of capital. The company treated 795,250 tons of ore in the year under review and recovered 190,506 oz. of gold. At June 30 the ore reserves were estimated as 653,000 tons averaging 7·8 dwt. in gold per ton.

LIBANON GOLD MINING made a profit of £684,852 in the year ended June 30 last, dividends totalling 7d. a share requiring £231,504. The mill dealt with 1,194,000 tons of ore in the year and recovered 282,399 oz.

of gold. Ore reserves at June 30 last were estimated as 2,505,000 tons averaging 4·9 dwt. in value.

The report of HARTEBEESTFONTEIN GOLD MINING for the year to June 30 last shows a surplus of £6,588,117 of which dividends equal to 70% required £3,150,000. From the 1,044,000 tons of ore treated, 570,095 oz. of gold and 1,053,532 lb. of uranium oxide were recovered. Ore reserves at 2,633,000 tons were graded at 9·74 dwt. in gold and 0·825 lb. of uranium oxide per ton.

RAND LEASES (VOGELSTRUISFONTEIN) GOLD MINING reports a surplus of £231,453 for the year to June 30 last, of which £135,000 was set aside for the reduction in capital. The mill crushed 2,206,000 tons in the year and recovered 324,160 oz. of gold. The ore reserves at June 30 are given as 1,920,000 tons averaging 4·2 dwt. in value.

The operations of BLYVOORUITZICHT GOLD MINING during the year to June 30 last resulted in a profit of £3,732,313, of which dividends totalling 2s. 1d. a share require £2,500,000. From the 1,349,000 tons of ore treated in the year 877,250 oz. of gold and 668,985 lb. of uranium oxide were recovered. Ore reserves at June 30 last are reported as 6,203,000 tons averaging 14·1 dwt. in gold and 0·522 lb. of uranium oxide per ton.

In the three months to September 30 last DOMINION REEFS (KLERKSDORP) treated 125,780 tons of ore and recovered 133,472 lb. of uranium oxide, the working profit being £255,620.

The accounts of ROOIBERG MINERALS DEVELOPMENT for the year ended June 30 last show a profit of £118,339 and £198,674 available, of which dividends and a bonus totalling 22½% require £45,000. The 73,906 tons of ore treated in the year yielded 1,026 long tons of high-grade and 173 tons of low-grade tin concentrates.

In the September quarter MESSINA (TRANSVAAL) DEVELOPMENT produced 260,825 tons of ore containing 3,403 tons of recoverable copper.

Orange Free State.—Earlier this month the directors of WESTERN HOLDINGS announced that bore-hole MH 2, drilled approximately 4,000 ft. due west of No. 3 shaft for the purpose of determining the probable position of the sub-outcrop of the Basal Reef, intersected that reef horizon at 1,595 ft., assaying 0·9 dwt. of gold per ton over a corrected width of 5·7 in. Two reefs in the hanging-wall, at 1,525 ft. and 1,578 ft., respectively, assayed 7·8 dwt. of gold per ton over a corrected width of 10·6 in. and 4·7 dwt. per ton over a corrected width of 35·3 in.

On October 16 shareholders of PRESIDENT STEYN GOLD MINING were informed that two bore-holes, drilled from the surface for pre-cementation purposes at the site of the No. 3 shaft system, intersected the Basal Reef with the following results: Bore-hole No. 1 cut the reef at 4,624 ft., the core assaying 25·9 dwt. of gold per ton over a corrected width of 23·7 in. Bore-hole No. 2 intersected the reef at 4,597 ft. and the core assayed 11·3 dwt. of gold per ton over a corrected width of 30·7 in.

In his statement to shareholders of HARMONY GOLD MINING at the annual meeting the chairman said that the fourth 50,000-ton-per-month unit of the gold reduction plant is on the point of completion. The sulphuric acid plant, with a rated capacity of 120 tons per day, was completed recently and test-running has commenced. Based on the existing demand it is estimated that profits arising from the sale of acid will be of the order of £150,000 per annum. Foundations for the second rock hoist at No. 2 shaft have been completed and it is anticipated that this unit will be commissioned during the first quarter of 1960. The normal hoisting capacity of the mine will then be in excess of 300,000 tons per month. In the year to June 30 the company made a profit of £3,844,796 and paid dividends totalling 2s. 1½d. a share requiring £1,912,500. The 1,312,000 tons of ore crushed in the year yielded 522,310 oz. of gold and 659,448 lb. of uranium oxide.

Southern Rhodesia.—It was announced last month that RIO TINTO (SOUTHERN RHODESIA), in association with Mr. R. W. Rowland, has acquired a 100% shareholding in VULCAN MINERALS (PVT.), LTD., which owns the emerald deposit and certain other mineral claims in the Belingwe district of Southern Rhodesia. It is stated that a great deal of work remains to be done before it is possible to estimate the potential value of the deposit, but Rio Tinto is to carry out a full geological and mining survey of the area and in consultation with the Southern Rhodesian Government give due attention to the highly specialized business of marketing the emeralds.

With the report for the September quarter, during which 265,950 tons of ore milled and concentrates containing 3,084 tons of copper produced, shareholders of M.T.D. (MANGULA) were informed that now that the milling plant

has been completed with the installation of the second Aerofall mill unit the directors have decided that a report will be published each quarter giving similar information.

In the year to June 30 last the CAM AND MOTOR GOLD MINING CO. (1919) made a profit of £414,373, of which dividends totalling 40% require £225,000. In the year the 379,499 tons of ore milled yielded 124,455 oz. of gold. At June 30 last the ore reserves were estimated to be 1,540,740 tons. It has been announced that RIO TINTO (SOUTHERN RHODESIA) has offered to purchase for cash at 11s. per share the whole of the issued share capital of Cam and Motor.

Northern Rhodesia.—Last month the BRITISH SOUTH AFRICA COMPANY announced that its estimated gross revenue from mineral royalties, rents, and fees for the quarter ended September 30, after providing for the payment to the Northern Rhodesia Government of 20% of the net revenue derived from the exercise of its mineral rights in Northern Rhodesia, amounted to £2,544,000.

Preliminary figures for the year to June 30 have been issued by MUFULIRA COPPER MINES and CHIBULUMA MINES. Mufulira's profit, out of the production of 88,056 tons of new copper, is given as £3,964,418, subject to audit, while Chibuluma, which produced 19,235 tons, earned £1,144,676. In the same year RHODESIAN SELECTION TRUST made a profit of £1,672,687.

With the recent dividend notice shareholders of the RHOKANA CORPORATION were informed that the directors propose to recommend that the sum of £22,500,018 standing to the credit of profits appropriated for capital expenditure, as at June 30, 1959, be capitalized and distributed to members by way of a capital bonus issue in the ratio of nine fully-paid bonus shares of £1 each for every existing ordinary and "A" stock unit held on January 4, 1960. The proposal is subject to members approving an appropriate increase in the authorized capital of the company.

Nigeria.—Last month shareholders of TIN FIELDS OF NIGERIA were informed that an offer of £12,100 for the company's properties and other assets in Nigeria had been accepted by the directors.

Tanganyika.—In the three months to September 30 last GEITA GOLD MINING treated 55,860 tons of ore and recovered 10,507 oz. of gold. The working profit for the period is given as £10,836. The report says that bore-hole No. 17 intersected the ore-body at 1,140 ft., where it assayed 2·8 dwt. over approximately 5 ft.

The accounts of URUWIRA MINERALS for the year to March 31 last show a loss of £114,662, which increases the debit carried forward to £369,738. In the year 310,665 dry metric tons of ore yielded 11,217 tons of concentrates averaging 41·07% lead and 13·67% copper, with 1,810·3 grams of silver and 28·19 grams of gold per ton.

Belgian Congo.—With the recent dividend notice shareholders of the UNION MINIÈRE DU HAUT-KATANGA are told that industrial operations continue to be very satisfactory and not affected by the political situation prevailing in the Congo. The copper output for the financial year, it is stated, will probably reach 270,000 metric tons, as compared to a production limited to 235,500 tons in 1958 and to a previous maximum of 247,500 tons in 1956. New construction is progressing, the main work accomplished covering the new Luilu plant, the Kambove-West concentrator, a mining shaft at Kamoto, and an improved hoisting installation at the Kolwezi mine. The Luilu plant will develop into an important automated complex for the leaching of electrolytic copper and cobalt ore.

Australia.—At the official opening of the new copper refinery in Townsville, Queensland, last month Mr. G. R. Fisher, chairman of Mount Isa Mines, said the refinery output should rise to 100,000 tons of refined copper annually within a few years, two and a half times present capacity. By late next year, when output would rise to 60,000 tons, expenditure on the refinery would have exceeded £A5,000,000. The mine's daily output is now averaging over 8,000 tons of ore daily. In the year ended June 30 last 2,278,579 tons of ore was treated, 57,035 tons of lead bullion and 4,791 tons of lead-copper dross, 27,280 tons of zinc concentrate, 41,945 tons of blister copper, and 38,685 tons of copper concentrates being produced. The net income for the year was £A3,972,371, from which dividends totalling 9d. a stock unit were paid.

In the three months to September 30 last MARY KATHLEEN URANIUM milled 120,000 short tons of ore and produced 375,000 lb. of uranium oxide. The profit for the period was £A503,182.

Malaya.—Shareholders of MALAYAN TIN DREDGING have been informed that the directors have decided to recommend the increase of the authorized capital to £2,000,000 and the capitalization of £926,222, as to

£23,143 being the amount standing to the credit of the share premium account and as to £903,079 being the amount set aside towards cost of a new dredge. If the recommendations are adopted shareholders will receive one new fully-paid share of 5s. for every one share of 5s. held. An extraordinary general meeting to give effect to these proposals is to be held on December 18.

It has been announced that the SUNGEI BESI MINES has received over 80% acceptances in regard to the offer to acquire the issued shares of HONG FATT (SUNGEI BESI) and the board of Sungei Besi has decided to make the offer unconditional. Further acceptances will be taken up to November 30.

Last month the boards of GOPENG CONSOLIDATED and KINTA TIN MINES said they have agreed to recommend a merging of the interests of the two companies. It is intended that this should be effected by Gopeng offering to acquire the whole of the issued share capital of Kinta on the basis of nine stock units in Gopeng for each five shares in Kinta. A merger will, it is stated, facilitate more efficient deployment of the labour forces and the concentration of the producing units and permit the introduction of a unifying scheme of future development.

Canada.—Early this month it was announced that RIO TINTO and DOW CHEMIE A.G., which is the Swiss subsidiary of the DOW CHEMICAL COMPANY, have jointly acquired the share capital of THORIUM, LTD., from IMPERIAL CHEMICAL INDUSTRIES, LTD., and HOWARDS AND SONS, LTD. Thorium, Ltd., was founded in 1914. It is the principal processer of crude thorium materials in the United Kingdom and has works at Widnes, Lancashire. Rio Tinto and Dow, it will be recalled, have been associated since the formation in 1958 of RIO TINTO DOW, LTD., a Canadian company which is producing crude thorium salts from the treatment of the barren liquors from uranium extraction at Rio Tinto's Algom Quirke mine, in the Blind River area of Ontario, Canada. The Rio Tinto Dow thorium plant, which came into production in May, 1959, is the first of its kind in the world and uses a solvent extraction process. Rio Tinto Management Services (U.K.), Ltd., has assumed management of Thorium, Ltd.

DIVIDENDS DECLARED

* Interim † Final

(Less Tax unless otherwise stated.)

***Ayer Hitam Tin Dredging.**—4½d., payable Nov. 20.

***Central Norseman Gold Corporation.**—1s. 9d. Aust., payable Dec. 11.

†Consolidated Gold Fields of South Africa.—3s. 9d., payable Dec. 17.

†Coronation Syndicate.—4d., payable Dec. 10.

***General Mining and Finance Corporation.**—Ord. 2s., payable Dec. 4.

***Gold Mines of Kalgoorlie (Aust.).**—1s. Aust., payable Dec. 3.

***Gopeng Consolidated.**—3d., payable Nov. 6.

***International Nickel Co. of Canada.**—65 cents U.S. *plus* 40 cents, payable Dec. 21.

†Kamunting Tin Dredging.—10½d., payable Nov. 27.

†Lake View and Star.—1s. 6d., payable Dec. 18

†Loloma (Fiji) Gold Mines.—1s., payable Dec. 18.

†London and African Mining Trust.—3d., payable Dec. 16.

McIntyre Porcupine Mines.—50 cents payable Dec. 1 and $1·00 payable Jan. 4.

Malayan Tin Dredging.—*3d., payable Nov. 27; †6d., payable Dec. 31.

†Mufulira Copper Mines.—3s. 9d., payable Dec. 21.

†New Guinea Goldfields.—3d. Aust., payable Dec. 9.

†North Broken Hill.—3s. Aust., payable Dec. 2.

†Offin River Estate.—1½d., payable Dec. 18.

†Pahang Consolidated Co.—10%, payable Dec. 12.

***Petaling Tin.**—10%, payable Nov. 25.

Premier (Transvaal) Diamond Mining.—Pref. 12s. 6d., payable Nov. 28.

†Renong Tin Dredging.—6d., payable Dec. 15.

†Rhodesian Anglo American.—6s., payable Dec. 17.

†Rhodesian Selection Trust.—9d., payable Dec. 21.

†Rhokana Corporation.—52s., payable Dec. 17.

***Siamese Tin Syndicate.**—3d., payable Dec. 18.

Southern Malayan Tin Dredging.—*3d., payable Nov. 25; †3d., payable Dec. 30.

***Sungei Besi Mines.**—1½d., payable Nov. 18.

***Tanjong Tin Dredging.**—6d., payable Nov. 7.

***Tronoh Mines.**—4½d., payable Nov. 13.

***Union Corporation.**—1s.

***Union Minière du Haut-Katanga.**—600 francs, free of tax, payable Jan. 5.

†Wankie Colliery.—9d., payable Dec. 8.

METAL PRICES

November 9.

Aluminium, Antimony, and Nickel per long ton; Chromium per lb.; Platinum per standard oz.; Gold and Silver per fine oz.; Wolfram per unit.

	£	s.	d.
Aluminium (Home)	180	0	0
Antimony (Eng. 99%)	190	0	0
Chromium (98–99%)		7	2
Nickel (Home)	600	0	0
Platinum (Refined)	28	10	0
Silver		6	8¼
Gold	12	10	2
Wolfram (U.K.)		—	
(World)	6	2	6

Tin, Copper, Lead, Zinc — See Table, p. 272.

Natural Gas in Alberta

H. L. Holloway, A.M.I.M.M.

An account of the place of gas development in the economy of the Province.

Introduction

The economy of the Province of Alberta is closely linked with the natural gift of a bounteous reserve of petroleum and gas underlying its soil. The natural gas not only serves as a source of power and heat to a great relative degree for industry and for the 1,200,000 population of the Province, but by the export of the commodity makes a notable contribution to revenue.

The history of the discovery of natural gas goes back to 1883, when it was struck in the course of water-well sinking along the route of the newly-built Canadian Pacific Railway. In 1890, during the process of coal prospecting, it was again found at Medicine Hat and in the following years the discovery was followed up and development of the natural resource was initiated. In 1909 a gas well was completed near Calgary and by 1912 a 16-in. pipe-line had been constructed from Bow Island, near Medicine Hat, to that city, a distance of 174 miles.

Following the discovery of the Turner Valley field in 1914 an impetus was given to exploration and discoveries in ever-increasing commercial significance have followed through Southern, Central, and North-Western Alberta. In the same year gas was discovered 75 miles south-east of Edmonton, near Viking, and in 1923 gas was piped to the capital city. As further discoveries throughout Southern and Central Alberta followed a Provincial gas pipe-line grid was established, progressively serving more and more the needs of the more settled areas.

The production of natural gas is intimately linked with that of crude oil, many wells producing both commodities in marketable quantities. The ratio of purely gas wells to crude oil and crude oil-natural gas wells is as 7% to 93%. To the utility derived from the use of the natural gas must be added the production of derivatives obtained by processing—natural gasoline, propane, butane, and sulphur.

Geology of the Gas Fields

All but the north-eastern corner of the Province of Alberta lies within the Western Canada Sedimentary Basin (W.C.S.B. in succeeding references), which is the northern portion of the Great North American Plains area, extending from the Gulf of Mexico to the Arctic regions. It is shown as a shaded area in Fig. 1. The area favourable to the occurrence of petroleum and natural gas in Alberta is estimated at 213,500 sq. miles. The floor of the W.C.S.B. is formed by Pre-Cambrian rocks and these have been covered by strata formed by sediments of the succeeding geological ages. Brian Hitchon in his "*Summary of the Geology of the W.C.S.B.*" written in 1959, gives the known occurrences of natural gas in place as being in the following percentage relationship to sediments of Paleozoic and Mesozoic ages :— Upper Cretaceous, 6% ; Lower Cretaceous, 34% ; Jurassic, — ; Triassic, 15% ; Permo-Pennsylvanian, 3% ; Mississippian, 27%, and Devonian, 15%.

The eastern boundary of the W.C.S.B. is formed by the Cambrian Shield and is clearly defined, while the western boundary is formed by the faulted and folded strata of the Rocky Mountains area with more complex definition. The base of the W.C.S.B. on the U.S.A. frontier is some 800 miles wide covering the whole of the southern boundaries of Alberta and Saskatchewan and part of Manitoba. The width of the basin narrows to the north to some 400 miles in the North-West Territories and again opens somewhat towards the Arctic. The sediments of the Cretaceous (Upper and Lower), Jurassic, and Triassic ages are predominantly sandstones, while those of Paleozoic age are

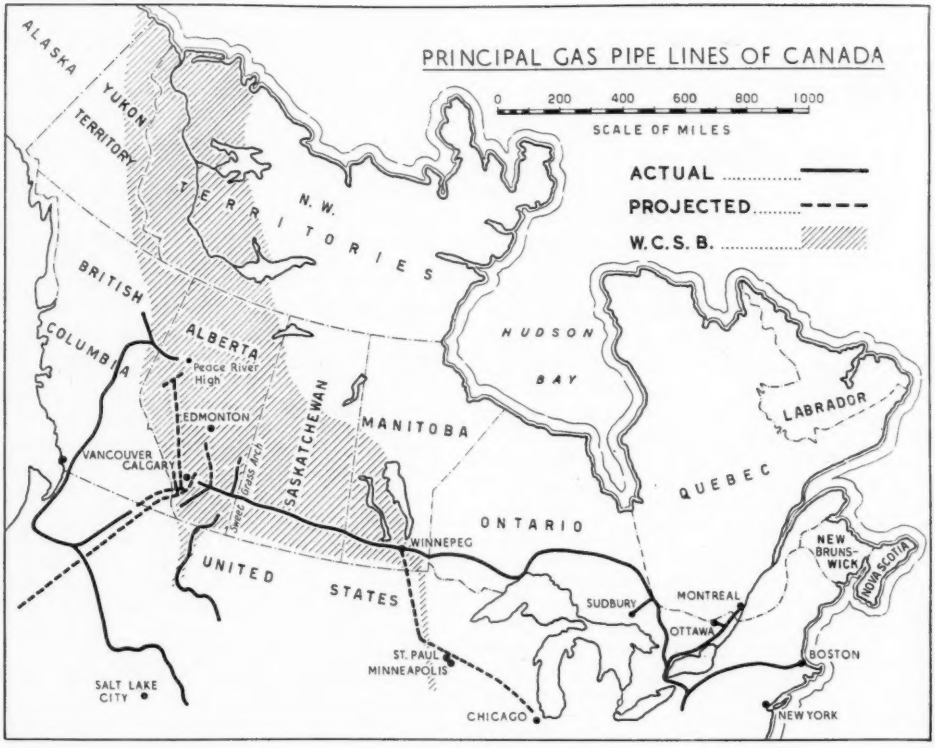


Fig. 1.

dolomites and limestones. The Tertiary strata are mostly of non-marine origin and are not favourable for formation of hydrocarbon deposits, but may be favourable as storage rocks.

The structure in Alberta is that of a shelf to the east and a syncline to the west with maximum thickness of sedimentary cover some 15,000 ft. The beds dip gently from the Sweet Grass Arch in Southern Saskatchewan and from the Canadian Shield in Northern Alberta towards the west, with an arch forming the Peace River "High." The sedimentary strata of the Foothills and the Rocky Mountains and the present Plains were originally an identical series, but the thrust producing the Cordilleran features induced regional faulting, folding, and overthrusts, resulting in a complicated geological structure with, in places, almost vertical dips. Both oil and gas are produced from favourable locations within this Rocky Mountains-Foothills deep region of faulting and folding and, currently, known fields are being extended in this zone and important new discoveries are being made both in Southern and Northern Alberta, with host rocks frequently of Mississippian age.

Research is being continued by the Research Council of Alberta to attempt to establish the origin of the hydrocarbon deposits and interesting results[1] have been obtained by this body from experiments to determine whether the degradation of chlorophyll could account for certain structures present in crude oil.

Exploration

The lead is given to exploration by the Provincial and Federal geological survey parties which are kept in the field, the Federal parties naturally not confining their work to Provincial boundaries. The major oil companies also keep their own geological parties to lay down the pattern for more intensive prospecting, which in uncomplicated

[1] 39th Annual Report Research Council of Alberta, page 20, heading (a).

structural formations is initiated by geophysical teams employing chiefly seismic but, to a lesser degree, gravity methods.

In the complex geology of the Foothills–Rocky Mountain zone geophysical work is at a great disadvantage and the geologist must be relied on to determine favourable areas for prospecting directly. Prospecting for crude oil and for natural gas must go together, as a well in a new area may strike either or both, but in extending known fields the expectation is that new wells brought in will conform to the production pattern of such fields.

Where natural gas from a predominantly crude oil well is not sufficient to make its utilization economical, it is burnt at the well head and it is a common sight in the oil-fields often far away in the unsettled forest, to see the spectacular flames of the burning gas.

Locations deemed favourable by the seismic parties are selected for drilling. Depths to gas-producing strata may vary from 2,000 ft. to 11,000 ft., the greater depths occurring in the deep Alberta basin towards the western boundary of the W.C.S.B. and the lesser depths in the Plains region and in the Peace River High.

Alberta has built magnificent trunk roads to all centres of major population and serviceable roads to outlying actual and to some potential centres and in the southern and central portions of the Province transport of exploration crews and equipment offers no special difficulty. It is otherwise in the large areas of roadless forests in the north of the Province. One railway runs north-west of Edmonton through the Peace River area, where lie large stretches of cultivated prairie, and another much less used track, due north to Waterways on the Athabasca River, by-passes the series of rapids which obstruct passage on the otherwise navigable stream. There is only one serviceable motor road serving the extreme north of the Province, with a loop joining it *via* Athabasca Landing and Lesser Slave Lake. The main road is part of the strategic Alaska Highway and is for the most part tarred as far as Valley View, 220 miles north-west of Edmonton, where a fork takes off to the Peace River area and on to the northern frontier to the North-West Territories.

The vast area of the northern portion of the Province not served by these railways and road must depend for transport on its water systems (in summer by boats, etc. and in winter by vehicles over the frozen surface), on the aeroplane and helicopter, and on specially-constructed vehicles. Considerable ingenuity has been exercised in the development of vehicles for use over snow-covered and soft ground and the Snowmobile is claimed to exert a ground pressure when fully loaded of only 2 lb. per sq. in.

Much work in difficult country is done in winter when the ground is frozen with the low point for exploration during the spring thaws. If this virgin country offers a challenge to the enterprise and endurance of its would-be conquerors the challenge has been fully accepted where the possible rewards bear some relationship to the initial financial

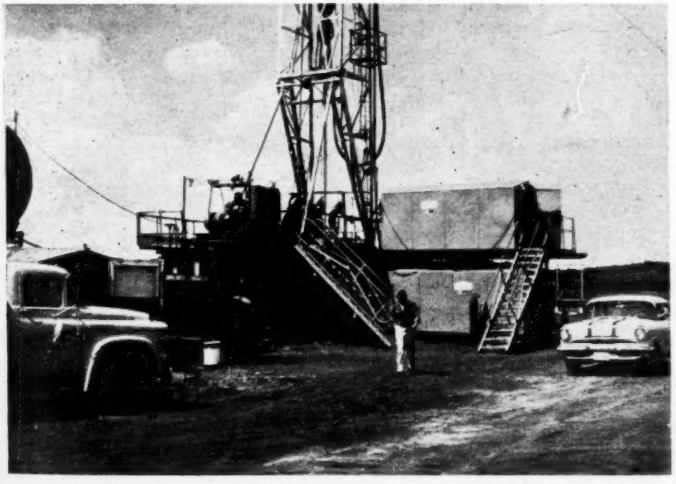


Fig. 2.—Drill Rig on Site.

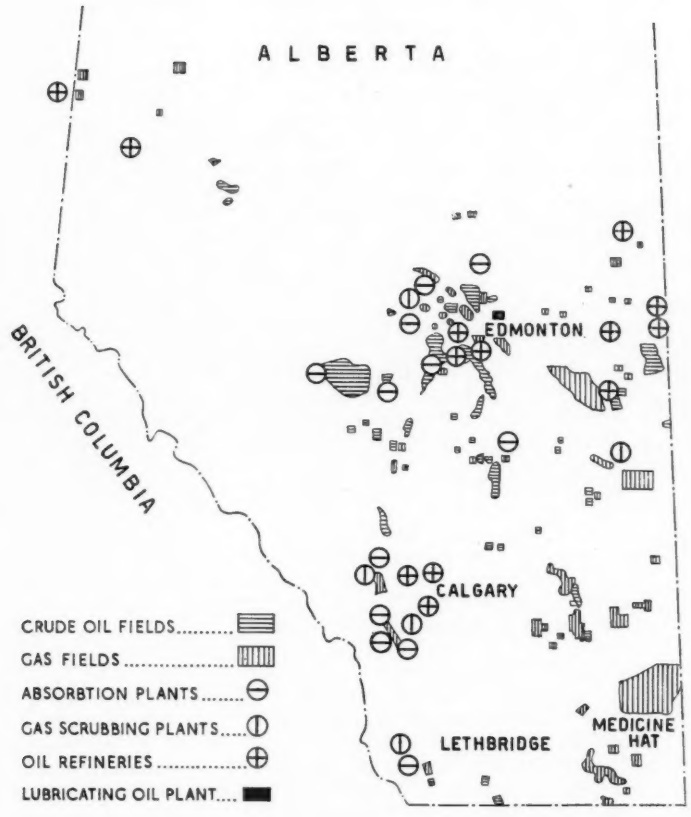


Fig. 3.—Gas and Oil Sites in Alberta.

outlay. In winter the therometer can, and does, reach *minus* 50° F., with a rare excursion to the *minus* 60°s, and in summer the plagues of biting and stinging flies have to be experienced to be appreciated. Not only are there mosquitoes (non-malarious) in millions, but also voracious blood-drawing "bull dogs," deer flies, and sandflies (who enter all but the most closely-woven nets and, where animals are used, drive them frantic by entering their ears), and the the soft-bodied, blood-sucking flies which burrow around the fringes of the hair in man and animals. As one periodically wipes away the last-named pest the hand, or handkerchief, comes away covered with a mixture of crushed flies, matter, and blood. The land is almost entirely forested with many streams, lakes, and patches of muskeg and swamp. The muskeg, a vegetable-coated morass, is the most difficult of all surface conditions to negotiate except when frozen.

Table 1

Reserves (trillions B.Th.U.)	*1954*	*1960*	*1970*	*1980*
Crude Oil	12,700	23,300	25,600	24,400
Natural Gas	15,320	22,700	34,000	35,000
Natural Gas Liquids	1,400	2,000	3,000	3,100
Totals	29,420	48,000	62,600	62,500
Total Production	602	1,746	3,016	3,610
% Export	67·9%	81·2%	85·5%	83·9%

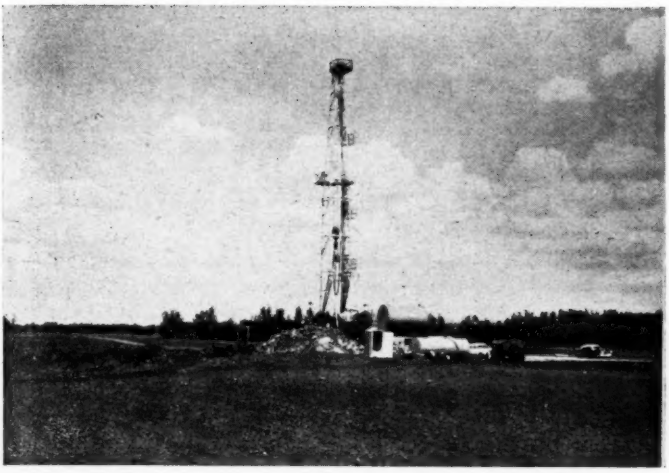


Fig. 4.— Drilling in Progress.

Development

The use of natural gas has already largely superseded the employment of manufactured gas throughout Canada and some 85% of the Canadian production comes from Alberta. Its value as a fuel is high, the content of the primary product varying from 900 to 1,150 B.Th.U. per cu. ft. and occasionally being still higher. Utilized gas is derived about one-third from purely gas wells and two-thirds from wells producing crude oil also. Wastage is high, amounting to 25 to 30%, and this is due in a large degree to the occurrence of the product in oil-wells where the quantity produced is too low to justify piping to centres of utilization. Table 1, from figures prepared by the Petroleum and Natural Gas Conservation Board of Calgary (P. and N.G.C.B.), gives the estimated production and reserves of Alberta crude oil, natural gas, and natural gas liquids. Growth of reserves is given in Table 2, compiled by the Department of Mines and Natural Resources (Information Circular M.R. 24, 1957). Throughout, both billion and trillion are used in the American acceptance—*i.e.*, 1,000 millions and 1,000,000 millions, respectively. B.Th.U.s are taken as being 1,000 per 1 cu. ft. of natural gas. The figure given in " Graphs of Growth " for 1957 is 21,000 b. cu. ft. and

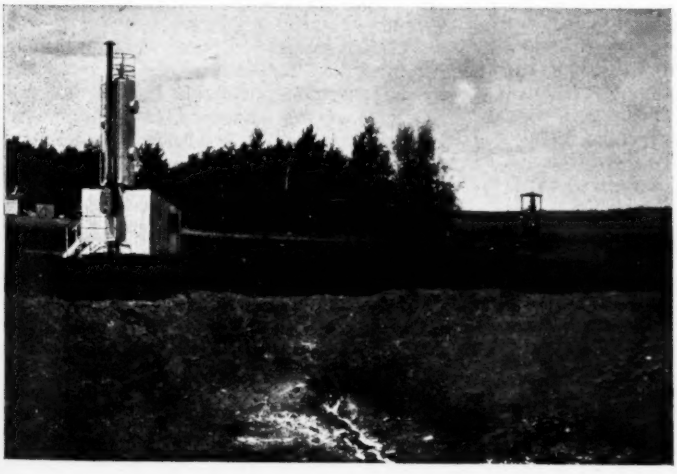


Fig. 5.— Completed Gas Well.

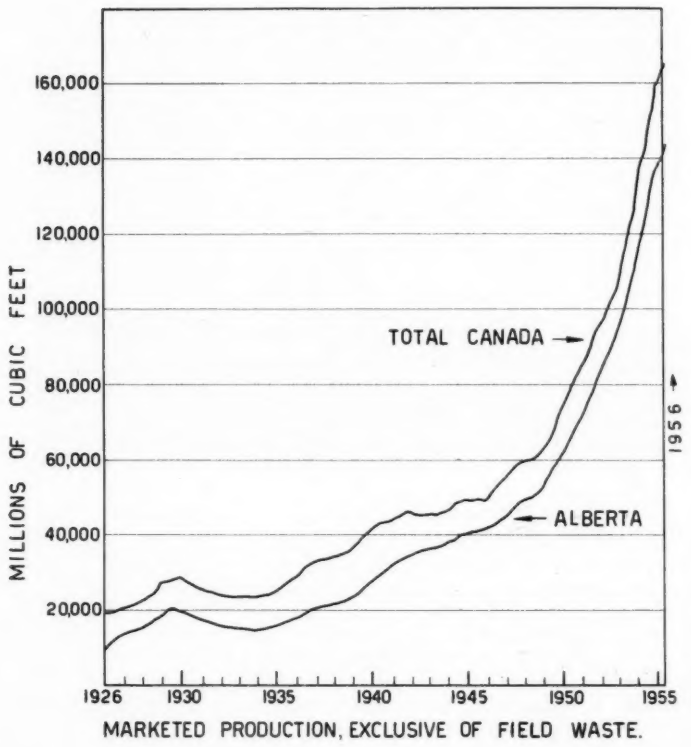


Fig. 6.— Canadian Gas Output.

Table 2

Year	*Reserves of Natural Gas* (Billions of cu. ft.)
Sept., 1956	18,300
June, 1955	15,600
March, 1954	13,400
June, 1953	11,500
Dec., 1951	6,800
Dec., 1950	4,700

the *per capita* consumption for Alberta as given in the Information Circular already quoted is 95,000 cu. ft. Average wages and salaries for workers in the mining industry including petroleum and natural gas are, for 1957, $93·2 per week (£34 10s.).

Natural Gas Products

An estimate of the quantity of natural gas expected to be treated for recovery of secondary products in 1958, prepared by the P. and N.G.C.B. of Calgary, gives the following (Table 3). The recoverable reserves are given in the same table for 1958 as being 420,000,000 barrels of natural gas liquids and 24,000,000 tons of sulphur. Fig. 3 shows the location of the natural-gas treatment plants together with other detail. Values of the natural-gas products are given in the same publication as being $2·90 per barrel for the natural gasoline, 3·9 cts. per gallon for naphtha, propane, and butane, and $25·00 per ton for sulphur.

Various industrial plants established in Alberta constitute major home markets for natural gas and its products, notable amongst them being the Petro-Chemical plant at Edmonton and the Sherritt Gordon plant at Fort Saskatchewan. Propane is widely used as fuel in districts outside the piped gas supply network. Consideration is being given as to the economic feasibility of piping supplies of liquified gas products to serve Central and Eastern Canada. The P.. and N.G.C.B. estimate an output of 2,750,000

Table 3

Natural Gas to Plant (billions of cu. ft.)	*Propane* (thousands of barrels p.a.) (35 Imp. gallons = 1 barrel)	*Butane*	*Gasoline*	*Sulphur* (thousands of short tons p.a.)
180	2,200	800	2,400	75

barrels of propane and 2,000,000 barrels of butane for 1960. The production of ethane will be developed as demand calls for it.

Marketing of Natural Gas

Pipe-line transport of natural gas developed rapidly to supply Provincial demand, domestic, and industrial, but its export was long delayed by political and financial negotiations and by Provincial considerations as to the amount which could be exported without long-term detriment to local needs. Provincial permission was obtained and other obstacles were surmounted by 1956 and during that year good progress was made in the construction of the 30-in. West Coast line to serve Vancouver and the Western U.S.A. and not so good progress on the 34-in. line to serve Winnipeg and points east.

Fig. 1 shows the development of pipe-line transport as it now exists. The West Coast pipe-line is served largely by production from the Peace River Block in British Columbia, but with important quantities also from the Peace River area of Alberta. It is designed and equipped with pumping facilities for an initial delivery of 400,000,000 cu. ft. per day, 75% of which is for the U.S.A., with a final transport of 660,000,000 cu. ft. per day after stepping up pumping equipment. The price paid at well-head is 10 cts. per M. cu. ft. and the sale price in British Columbia to major users is from 22 cts. to 30½ cts. per M. cu. ft.

The Trans-Canada line is of 34-in. diameter to Winnipeg and thence is reduced progressively as the larger cities *en route*, or served by branch line, draw on its throughput. The initial capacity was 300,000,000 cu. ft. daily to be increased first to 570,000,000 cu. ft. and finally to 780,000,000 cu. ft. Price paid for well-head gas is 10 cts. per M. cu. ft. and General Service rates in Eastern Ontario and Montreal are from 46·4 cts. to 52·1 cts. per M. cu. ft., with small general service rates, 67·5 cts.

Mining Laws and Ownership of Minerals

Laws governing mineral rights, including petroleum and natural gas, have changed as the control passed successively from the Hudson's Bay Company's dominion over all lands whose waters drained into the bay, covering practically all of Southern and much of Central Alberta, first to the Federal Government in 1869 and then to the Provincial Governments in 1930. Rights were retained by the Hudson's Bay Company to some 2,500,000 acres in Alberta when the agreement was made with the Federal Government and subsequently the Federal Government made grants of land, including mineral rights, to the Canadian Pacific and other railway companies, constituting substantial blocks along the trans-continental routes.

Prior to 1908 and 1912 respectively some early settlers taking up land from either the Hudson's Bay or the railways acquired mineral rights with the surface rights. When transferring control of natural resources to the Provinces in 1930 the Federal Government reserved some areas for Dominion Parks, Indian Reserves, etc., but after deducting these and those pertaining to the Hudson's Bay Company, to the Railways, and to private possessors, ownership of 81% of mineral rights in Alberta territory is vested in the Province.

In the light of experience gained in the working of the mining laws, following the rapid expansion of oil and gas production, changes have been deemed necessary in the granting of prospecting and mineral rights. As the law now stands a company or person can obtain reservations at the discretion of the Minister of Mines of up to 200,000 acres for oil and gas exploration upon payment of the prescribed fees and deposit; $250·00 and $2,500·00 per 20,000 acres respectively. The holder of a reservation is required to carry on actively with exploration work to the satisfaction of the Mines Department and is permitted to drill test wells. Following the discovery of gas (or oil) the holder of the reservation is required to apply for a licence of natural gas rights if it is gas which was struck, the fee being $250.00 with 5 cts. per acre rental. Working obligations must be carried out to the satisfaction of the Minister of Mines. Following the determination of gas in commercial quantities a lease must be applied for. Areas granted as leases are governed by the depth to the producing stratum, when less than 3,000 ft. six sections being allowed per well (a section is 640 acres) and when 6,000 ft. or over, 10 sections. Royalty payable to the Crown is 15% of sales value at point of production with a minimum of ¾ ct. per thousand cu. ft. (M. cu. ft.).

Acknowledgments.—In concluding this article grateful acknowledgments must be made to the staff of the Research Council of Alberta at Edmonton for information and literature so generously supplied and to the Director of Mineral Rights at Edmonton for information and papers regarding Mining Laws.

A Half Century of Progress in Metal Mining—2

The author's critical survey of practice is concluded.

G. Keith Allen, B.M.E., M.I.M.M.[1]

Support of Workings

Timber is the traditional material used for support and is still extensively employed in metal mines for the purpose. In the form of posts or stulls, framed sets in tunnels, shafts and stopes, practice has hardly changed in 50 years. Where greater strength or permanency is needed steel or concrete is still used.

The great working depths that are now being reached in metal mining have made the question of support of paramount importance and it is in the study of this problem that knowledge of the fundamental principles of mining have made considerable advance in recent years. Ingenious instruments and electronic methods have been devised to measure and predict ground pressures and practical results are being obtained. As a result of these studies the nature of rock-bursts in ultra-deep workings is better understood, though much has yet to be learnt. A direct outcome of work of this nature in South Africa is the technique developed there of destressing the ground at stope faces to relieve pressures before bursting point is reached.

The support of weak ground by rock bolting has come to the fore in the last 15 years and in many instances has taken the place of conventional timbering methods. Various systems of anchoring the steel bolt in the hole have been devised, such as expanding shells, slot and wedges, or grouting with cement. In some cases even wooden rods, anchored with slot and wedges at both ends, have proved successful. Stopers with short air feeds have been especially designed for drilling the holes where headroom is low.

Hydraulic pit props are a post war development. Originally intended for support in longwall coal mining they are now finding application in stratified metalliferous deposits. In South Africa, for example, they are being used in certain banket reef gold mines and in North America in uranium mining. Normally hydraulic props yield at loads of about 20 tons.

Yieldable steel arch sets, first used in European coal mines, are also finding increasing application in metal mines.

Concrete is being used more extensively than ever for support in underground workings. Scram drives, and other openings subject to heavy ground pressures, are being lined completely with concrete, plain or reinforced, depending on circumstances. By the use of light portable metal shuttering, with almost continuous pouring techniques, emplacement has been speeded up considerably.

For strengthening and consolidating loose ground cementation has long been used, though not always with success in water-bearing sand. Soil stabilization techniques, borrowed from civil engineering practice, have been used successfully where other methods have failed.

Stoping Methods

Despite the enormous increase in mechanization during the past 50 years, stoping methods differ little in essentials from what they were in 1909. From the simple hand-working methods of the period they have been modified to permit increasing use of machines, but open stoping, shrinkage, cut and fill, square setting, sub-level, and caving have remained for half a century and more the principal methods of underground mining. High output with concomitant low working costs is the trend of modern practice, since the demand for metals is greater and high-grade ore-bodies are rarer.

In the following no attempt is made to describe mining methods more than is needed to indicate the changes that have taken place since 1909.

Open Stoping.—In open stoping support is provided by the inherent strength of the rock,

[1] Reader in Mining in the Royal School of Mines; Past President of the Institution of Mining and Metallurgy.

which may be supplemented by pillars of ore or waste left for the purpose, or by artificial support—such as, stulls, packs, etc. Typical examples are underhand and overhand stoping of narrow, tabular ore-bodies of steep dip and breast stoping when dips are flat, or bench stoping in massive ore-bodies with strong walls.

Practice in steep stopes calls for little comment, for it has hardly changed in 50 years. Stulls are used to support the stope and on them are placed planks to form working platforms for drilling in overhand stopes, or barricades to protect the miners from falling rock when working below in underhand stopes. Stopers, bar-rigged jackhammers, and in the last 10 or 15 years jackhammer-air leg combinations, are used for drilling in the former, and hand-held jackhammers in underhand stopes.

Various changes in detail have taken place in open stoping flat narrow reefs, well illustrated by South African practice in the banket gold mines. Breast stoping best describes the method of mining, though faces may be carried slightly underhand, or even overhand. Hand drilling persisted in this field for many years after 1909 until the light jackhammer was perfected for drilling in narrow spaces and labour for manual work became difficult to obtain. A standard length of hole widely adopted is 42 in., based on early hand-drilling practice, but recently long-hole drilling, using mounted machines, is receiving attention in these mines. For handling the broken ore there has been a steady trend to replace hand shovelling by shaker conveyors and scrapers, the latter now being the chief of these used for the purpose. They are used to scrape the ore from the faces into the chutes at the bottom of the stope, into cars on stope tracks, or along scraper tracks to a centre gully, and in the gully to a main chute at the bottom.

Stulls, timber packs, and waste packs have changed little, but a recent innovation is the use of hydraulic props in some stopes where a system of longwall mining is practised.

Mining at great depths in this field is presenting many problems of support which are being successfully solved by changing from true open stoping to that of longwall mining, with controlled hanging-wall caving in the worked out section, and by destressing the ground at the face, as previously referred to under " Support of Workings."

In open stoping of massive deposits the great advance has been the use of trackless vehicles in recent years. Owing to the larger size of such workings a relatively high degree of mechanization was possible much earlier than in other forms of underground mining. Thus before the specially-designed shovels for use in restricted spaces were designed, small full-revolving shovels of the type used on the surface were working underground in some of these stopes. Electric trolley locomotives were also being used and, with the ore mined in benches, some of these stopes took on the appearance of open-cast workings. They are to-day being mined on much the same lines, but with modern equipment such as multi-drill jumbos, shovel loaders, and self-propelled trucks which have already been mentioned.

Shrinkage.—Shrinkage stopes are overhand stopes in which the ore accumulates until the stope is finished, enough ore being drawn off after each face advance to provide a working platform from which to drill. The method became more widely employed after the introduction of the stoper drill, which was designed to drill overhand holes some years before 1909. Changes in practice since then are related mainly to the development of machine drills and loaders.

Upper holes drilled by stopers are liable to leave the backs of the stopes in a badly shattered and unsafe condition. In such circumstances drilling flat holes in benches with drifter machines is preferred. In the last 15 years the jackhammer-air leg combination has largely replaced the drifters, since with these one man can drill a round of bench holes that previously would have required two. Longhole drilling from a raise at one end, with jointed drill rods, is sometimes used as an alternative to bench drilling.

Changes in ore drawing methods have taken place also. The old method of drawing through chutes at intervals of 15 ft. to 25 ft. along the tramming drive, though still practised, has been replaced in many instances by the so called scram drive above the tramming level, along which the ore is scraped to a chute at the end. This gives a saving in cost and maintenance of chutes and leaves the tramming drive freer from obstruction. The system is not generally suitable for narrow ore-bodies, however, because of the cost of the extra development needed and the loss of ore in the pillar that must be left between the tramming level and the scram drive.

Cut and Fill.—This also is an overhand system and changes in drilling practice have followed the lines as mentioned in shrinkage

stoping. It is used in ground where the walls are weak and would collapse and dilute the ore during drawing were shrinkage stoping adopted. The method consists of mining the ore in slices for the length of the stope and running in waste to fill the space when the broken ore is removed. Enough room is left between the waste and the solid ore to mine another slice. The broken ore is transferred through cribbed or lined passes in the waste to the tramming level below.

Two systems of mining are used; one in which the ore is mined in horizontal slices and the other in inclined slices.

In horizontal cut and fill the broken ore was shovelled to the ore-passes by hand and hence they were spaced fairly closely together, 25 ft. to 35 ft. being usual. In modern practice scrapers, or mechanical loaders with shuttle cars, are used and this permits wider spacing of chutes with a saving in first cost and maintenance. A floor of timber planks or flat sheets is laid on the levelled waste before the ore is blasted. This not only makes for clean mining, but provides a good base upon which to move the ore by scraping or shovelling. Waste-rock fill is dropped down waste rises and spread by cars or wheelbarrows in small stopes. Scrapers or shaker conveyors are also employed for waste spreading. Recently, shuttle cars specially designed for working in such stopes and for use with a loader for removing the broken ore have proved most efficient machines.

Sand, brought in by water through boreholes or pipes, has been used for fill for many years. It is better than waste rock for the purpose, as it fills all the spaces and dries out with a level surface. Dry sand fill is sometimes blown in by compressed air, but this method is more expensive and less commonly used.

In the inclined system the slices are mined at an angle of 35° to 40° to the horizontal and thus the broken ore and waste move by gravity. The method saves labour, but other operations in the stope become more arduous and the same end has been gained to a great extent in the horizontal system by the use of scrapers and loaders.

Loading on the tramming level has hardly changed in 50 years. Ore trains filled at chutes in cross-cuts or on the main level is still standard practice.

Square Setting.—Square setting dates from about 1860, when it was first used on the Comstock lode, Nevada. By 1909 it was one of the principal stoping methods of the day for ores that required close support while being mined. Probably no other method has changed less since then. It yields a high percentage of extraction, but is expensive in labour and timber and for this reason other, cheaper, methods are usually now preferred, even if they result in a lower recovery of ore.

It is essentially an overhand method, though in exceptional circumstances it may be worked underhand—as, for example, in the Mitchell system for mining pillars between worked-out filled stopes. Since it is used only in weak ground, drilling is of less importance than support and heavy blasting is ruled out on account of risk of damage to the timbers. The size and framing of sets have changed little; if anything the latter has become simpler in design. Ore handling on the stope floors is still mainly by hand shovelling, since access to the ore-passes can be kept close to the rock pile by means of timber slides built in the sets. If the walls also are weak the sets are filled and to aid the operation a rill system of working is usually employed; otherwise scrapers or cars may be used for spreading the fill.

Square setting to-day is used mostly as a safe system for the reclamation of pillars rather than as the principal method of mining an ore deposit.

Sub-Level Stoping.—This is an open stoping method, originally used in Michigan, U.S.A., about 1902, and one of the most widely employed systems for mining ore deposits in which the ore and walls are of good standing ground. Stope preparation work is considerable and for this reason it is rarely used in ore-bodies less than 15 ft. wide. For these, shrinkage stoping would be the alternative.

In preparing a block sub-levels at vertical intervals of 30 ft. or more are driven strikewise from rises in the end pillars and a slot is cut from foot-wall to hanging-wall at one end. In the earlier systems a bench, known as a trail, was cut across the ore-body at the ends of the sub-levels where they open into the slot and from them the ore was drilled and blasted into the open space. New trails were cut as required and the process repeated until the pillar line at the opposite end was reached. Changes in this practice have taken place due to the development of ring drilling. In this system rings of long holes, drilled in various patterns so as to cover the whole width of the ore-body, are drilled in parallel fans which are blasted in rotation into the slot.

Both diamond drills and percussive

Cage Rising in Northern Rhodesia.

machines with jointed or flexible drill rods are used for drilling the rings. Detonating fuse and short-delay electric blasting or igniter cord are used for detonating the explosive.

There are many variations of the method, designed to suit local conditions. For example, the slot may be cut on the foot-wall, parallel to the strike, and the rings may be drilled either from the sub-levels themselves or from cross-cuts from them. One of the advantages of ring drilling over the trail method is that the rings can be drilled in safety well ahead of blasting. The ore falls to the bottom of the open stope, where it passes through draw points to bull-dozing chambers on the grizzly level and thence through ore-passes to the haulage level below. A variation of this layout is the use of a scram or scraper drive, instead of a grizzly level, along which the ore is scraped to a grizzly and ore pass at the end.

Although primarily designed for steeply-dipping ore-bodies the method has been applied successfully to dips as low as 35° by using scrapers to draw the broken ore to the grizzly level.

The high cost of stope preparation is largely offset by the efficient ore breaking and high output per man shift in sub-level stoping.

Top Slicing.—This caving method originated in the soft iron-ore mines of North England well before the end of the 19th Century and by 1909 was well established in all parts of the world for mining weak ores overlain by capping that would cave after support was removed. Mining starts at the top of the ore-body, immediately below the capping and proceeds in slices downwards. From headings on each slice level the ore is first completely mined out by driving a succession of timbered drives and cross-cuts. When this has been done the timbers are collapsed by blasting, thus causing the capping to collapse. An essential feature is the formation of a mat of broken timber between the ore and capping which prevents them mixing. Several slices may be mined concurrently, each retreating in succession from the stope boundary to the rise. Originally the ore was shovelled or hand-trammed to the chute, but later, in order to save labour, slices were often driven sloping

so that the broken ore could gravitate to the ore-passes. By 1918 scrapers were being used for moving the ore and are credited with doubling the output per man.

Except for mining pillars the method is not greatly used to-day. Large deposits, which previously would have been top sliced, are now more likely to be mined by sub-level or block caving.

Sub-Level Caving.—This method is not unlike top-slicing, from which it was evolved. The principal difference is that in sub-level caving the sub-levels are spaced further apart vertically so that a thickness of solid ore lies between the top of one sub-level and the bottom of that above. When the sub-level timbers are collapsed by blasting the slice of ore above caves and is followed by the capping. The timbers are blasted set by set, commencing at the outer boundary of the ore-body, and the broken ore is removed from one caved set before the next is blasted. Thus part of the ore is broken by explosives and part by caving.

The method was devised to reduce the large quantity of timber used in top slicing and, incidentally, some of the drilling and blasting cost. In this system the ore must be strong enough to hold the capping in place while the slice is being mined, but weak enough to cave when the support has been removed. In this form the method has not much application to-day.

A form of top slicing without the use of timber is widely employed in mining large massive deposits. It is generally known as sub-level caving and was practised in the Kimberley diamond mines well before 1909. Parallel sub-levels were driven through the blue ground of the diamond pipe below the old open-cast workings at 40-ft. vertical intervals to the wall of the deposit. These were enlarged both horizontally and vertically by overhand stoping, the miners standing on the rock pile, until they connected and a long stope was formed against the wall. The ore was trammed out along the sub-levels and, as stoping advanced back along each level, another stope was broken through from below and so on until stoping was proceeding on several levels. As the work progressed the broken ore flowed downwards and was drawn off at each level.

In the modern version of this method sub-levels are at intervals of 30 ft. to 60 ft., both horizontally and vertically, and the ore is stoped by ring drilling. Mechanical shovels, loading shuttle cars, self-propelled trucks, or ore trains are now used for removing the broken ore. The capping caves on top of the ore and one of the drawbacks of the method is that dilution may be high—20% to 30% not being uncommon.

Block Caving.—The origins of block caving go back to 1895 when it was developed for mining iron ores at the Pewabi mine in Michigan. In 1906 an undercut block caving system was laid out at the Ohio copper mine in Bingham, Utah, and in 1911 there started the notable applications at Inspiration and Ray mines, Arizona, followed by Miami, in 1914. Such was the success of the method in mining low-grade copper deposits that it became in many instances a serious rival to open-cast mining.

In the original system at Pewabi a block 100 ft. high was caved, but since then the technique has been so greatly improved that blocks 300 ft. high or more can now be caved successfully with one undercut. The principle of the method is simple. The block, which may be some 300 ft. square in plan though usually smaller than this, is weakened around its boundaries by narrow shrinkage stopes, boundary drives, and rises. It is then undercut across the whole area, which induces caving. The caved ore is drawn through finger rises from a grizzly level and caving extends upwards through the block as drawing continues. From the grizzly level the broken ore falls through transfer passes to the haulage level.

The successful operation of the method depends on two factors—the skill of miners in undercutting and the control of the draw exercised by the engineers. The slower the rate of draw the finer the comminution and the more evenly it is carried out the less the dilution by capping.

In early systems each grizzly served two finger rises to the undercut; later this was increased to four or eight, one grizzly thus being made to cover a larger area of caving. Also, each grizzly usually had its own ore pass to the tramming level below, until the branched rise system was introduced. By this means one loading chute could draw from two or three grizzlys on each side of the haulage. This saved in the number of haulage drives required at the lesser expense of extra length of passes in the branched system. Grizzly levels are subject to great ground pressures and commonly were very heavily timbered and kept as small as possible. Modern practice is to line them with thick monolithic concrete, or to replace

them by concrete-lined scram or scraper drives.

Panel caving is a form of undercut block caving in which the ore-body is divided into panels which are caved in succession in a continuous process from one end of the ore-body to the other.

Owing to the large amount of development needed block caving is suitable only for large deposits. It is used in a variety of these, including limestone, and in ground that at one time would have been considered unsuitable for the method.

Drainage

Progress in mine pumping practice in the past 50 years is related almost entirely to a change from steam to electricity as the prime motive power. Except that mine pumps are now driven by electricity or compressed air they are very similar to their steam-driven counterparts of 1909. At that time centrifugal pumps were not common underground; practically all metal-mine pumps were reciprocating ram pumps, mainly because with their external packing glands they were easier than piston pumps to maintain when dealing with gritty water.

Reciprocating pumps were either in tandem with a steam cylinder, as in the well-known Cameron range, or driven by a steam engine, directly or by means of gearing or belt. The tandem type is still used in shaft sinking and other auxiliary services underground, but driven now by compressed air.

Mine pumps driven by steam engines were generally triplex or quintuplex and were used for high-lift duties at main stations. When electricity became available electric motors with gear or belt drive replaced steam engines, which were sturdy reliable machines and some may still be found working in old mines.

The change from steam to electricity opened the way underground for the centrifugal pump, already established on the surface. For high lifts multi-stage pumps are used. A lift of 3,000 ft. is seldom exceeded on account of weight and pressure problems in the rising main.

To ensure trouble-free operation centrifugal pumps for main pumping plants should draw clarified water. Pump station layouts have become, in consequence, much more elaborate. Large settlers and sludge removal arrangements are provided, chemicals may be added to neutralize acids, flocculants to aid settlement, and, if the water is to be used for drilling, it may be filtered to reduce its silica content. On the other hand, considerable progress has been made in the design of centrifugal and other rotary pumps specifically for handling gritty water. Such pumps for draining in shaft sinking and other similar applications are displacing reciprocating pumps in this field.

Roof Bolting in a Canadian Mine.

The use of electricity has made possible the automatic and remote control of pumps and there are many installations of this kind in mines, with resulting savings in man-power.

Lighting

Underground lighting has made tremendous advances in 50 years and has been an important factor in improving the safety, efficiency, and comfort of the workers. Candles and oil lamps were commonly in use in 1909 and even as late as the 1920s candles were not unknown in many mines, supplementing carbide lamps. Carbide lamps were first introduced about 1909, first as hand and later as cap lamps and both types, though now superseded by electric cap lamps, are still used in many areas. Electric cap lamps were developed in the 1930s and are now almost universally used by underground officials and to an increasing extent by all underground labour.

For main haulages, shaft stations, and similar working places high-power electric filament lamps or fluorescent lighting has

for many years been the main method of illumination. In stopes, large development, headings, and shaft bottoms when sinking, floodlights are usual.

For use in sections of a mine where electricity is not available a portable unit consisting of a filament lamp and an air-driven generator, which can be connected to the compressed-air service, is a particularly useful accessory in the hands of a repair and maintenance crew.

Power

Steam was the principal source of power for mines 50 years ago, employed directly for driving hoists, compressors, and pumps. About the same time electricity was becoming more generally adopted, generators driven by steam turbines or steam engines being the usual combination. Plants of this type are still common. In places where water power is available hydro-electric installations are also an important source of power for mining districts.

Wood and coal have been the main fuels for firing boilers, but oil has also found favour, sometimes replacing wood when local timber supplies became exhausted. When good wood fuel or coal were not procurable producer-gas plants and gas engines have often been installed, since they can utilize low-quality timber. Diesel engines, driving electric generators or compressors, are also frequently used. They have an advantage in that they can be installed conveniently close to where the electricity or compressed air is required, thus effecting some saving in transmission lines or air mains.

Compressors.—Early compressors were reciprocating machines, driven by steam engines or by steam cylinders in tandem with the air cylinders. Twin-stage compressors, with inter- and after-coolers were among the first improvements introduced. Electric motor or diesel engine drive was a further development and this arrangement is probably the most usual to-day. Modern machines range in capacity from a few hundred to some 8,000 cu. ft. of free air per minute, a common size being about 2,000 cu. ft.

Rotary turbo-compressors are also used, especially on large installations. Their first cost is high and it is usually considered not economic to install units of less than 5,000 cu. ft. per minute.

The most recent type is the screw compressor, which is built in sizes up to about 25,000 cu. ft. per minute, with pressures from 60 to 150 lb./sq. inch. Among its advantages are its comparative ease in installation and compactness.

Compressed air is second only to electricity as a power source in metal mines. It is used for operating a wide variety of equipment from drills, loaders, hoists, locomotives, chute gates, ventilation doors, fans, and various control mechanisms.

Hoisting

Hoists.—The early hoists were steam driven and the largest were magnificent examples of engineering skill. Simple and reliable, they served the industry well and, though long outmoded by electric hoists, some can be found still at work in older mines. By 1909 electric hoists had appeared, but were few in number, mainly because electricity was not always readily available and was relatively costly. Direct-current motors, on account of their easy speed control, were first used, but the need for a converter set for each hoist was a drawback. Nevertheless, with Ward Leonard control, later in combination with flywheel converter sets for ironing out the peak power demands due to uncompensated winding loads, electric hoists eventually supplanted steam for deep winding.

In the meantime speed-control systems for alternating-current motors were developed and a.c. hoists rivalled d.c. hoists for medium-depth shafts. With the introduction some 10 to 15 years ago of dynamic braking, a.c. hoists invaded the field of deep-level winding, which until then was considered that of the Ward Leonard and both types are now in general use in metal mines throughout the world.

Electric hoists lend themselves to semi-automatic or automatic control. In the former an onsetter initiates each wind by push button and in the latter the completion of the skip-loading operation starts the wind. Hoists of this kind are not uncommon, one of the first being installed at the Inspiration copper mine in Arizona some 40 years ago or more. Skip loads of 12½ tons of ore were hoisted from a depth of 630 ft.

Several methods for equalizing out-of-balance winding loads have been devised and all predate 1909. They include the use of a tapered rope, a flat rope wound on a reel drum, the conical drum, and the tail rope. The first two are now obsolete.

The conical-drum hoist dates from 1775 and the principle is used in large hoists to this day. For their most efficient operation

Modern Man-Riding Train.

they are designed primarily for hoisting from one level and for this reason have been less favoured in metal mining than in coal. For the same reason the use of a tail rope has not found, in general, much application in metalliferous mining. The Whiting system, using double cylindrical drums and a powered rope carriage to allow adjustment of the length of rope in the shaft, was designed for hoisting from intermediate levels, but it was an awkward arrangement and is used no longer.

The Koepe friction hoist is the best known example of a tail-rope hoist, the tail rope being an essential part of the system. The hoist has found a wide application in Europe on account of the load-compensating characteristics of the tail rope, its relatively light weight, and the absence of fleet angle. The fear of excessive slip, among other reasons, inhibited its use in metal mining in many countries and it is interesting to note, therefore, that several have been installed in gold and copper mines in South Africa and Rhodesia in the last 10 years and that more are contemplated.

The most recent development in hoist design for winding from deep levels is one proposed by Mr. R. Blair of South Africa. It is a multi-rope multi-layer drum winder with a compensating device which ensures equal tension in the ropes and it can be fitted with a balance rope if desired. Full-scale tests have been conducted and it is claimed to possess all the advantages of the Koepe hoist with none of its drawbacks.

Ropes.—With one exception the ropes in use to-day are of similar construction to those of 1909. Ordinary or regular lay ropes, Lang's lay in which the wires and strands are twisted in the same direction, and locked-coil ropes were used well before the end of the 19th Century. The one exception is the preformed rope, which was not introduced until the 1920s. In this construction the wires and strands are processed to retain the desired helical twist in the final rope.

Ordinary lay, locked-coil, and preformed ropes have the non-spin characteristic which makes the use of such types essential in deep vertical shaft sinking and desirable in shafts with rope guides. Lang's lay ropes have better wearing qualities than those of ordinary lay and are commonly used for hoisting in vertical shafts with fixed guides.

High-tensile steel has been used for winding ropes for well over 50 years. Strengths up to 130 tons/sq. inch are satisfactory for general use, though steels of ultimate tensile strength as high as 140 tons/sq. inch have been used in some countries.

The size of ropes is determined primarily by the factor of safety, defined as the ratio of the ultimate strength of the rope to the maximum static working load. In most countries the minimum factor is prescribed by

Government Mining Regulations which in this respect have become more precise than they were in 1909. The permitted value for hoisting men is usually higher than for rock and varies between 10 and 4·5. It is related often to the conditions of hoisting—as, for example, in South Africa, where exemptions are given for ultra-deep hoisting, previously mentioned under " Shaft Sinking ".

Guides.—In 1909 shaft guides were invariably of wood in rectangular shafts and, commonly, in circular shafts ropes were used. As winding loads became greater steel guides, with steel or concrete sets, came into use. They are more rigid than wood and most modern large shafts are now equipped with them. They are either standard rail sections or rolled sections of various shapes. Until the late 1930s rubbing shoes were steel, with or without renewable liners. About this time rubber rollers for use with fixed guides were introduced and are greatly to be preferred to the old-type shoe. They have a minor drawback of adding weight to the conveyance, but give smooth silent running and reduce guide wear considerably.

Rope guides are still used, but mostly in coal mines. They are not convenient if the cages have to be loaded at intermediate levels, for special arrangements are then necessary to hold the cage steady. They are also not suitable for normal hoisting from depths greater than about 3,000 ft., for beyond this their deflection can reduce clearances between the cage and the shaft walls to the danger point. They have, however, been used in shaft sinking to 5,000 ft.

Headframes.—These have advanced greatly in design since 1909. At that time most headframes in metal-mining countries outside of Europe were built of timber, but steel construction had begun to be freely used on the larger properties. Some large timber headframes are still in operation, but few are now built except for small shafts during the early stages of a mine's life.

Reinforced-concrete open construction on the lines of steel headframes was first employed some 40 years ago and monolithic concrete is also well established. A more recent development is post-stressed rectangular construction, which is economical and rapid. Concrete headframes are well suited for tower-mounted Koepe hoists. Headframes of over 150 ft. high have been built of concrete and a feature of some mining fields to-day is not only their functional design but also their architectural beauty.

In cold climates headframes are usually totally enclosed and may include the hoist house, crushing station, miners' change house, and other offices. This lay-out has many operating advantages and might well be adopted in more temperate areas when building in concrete.

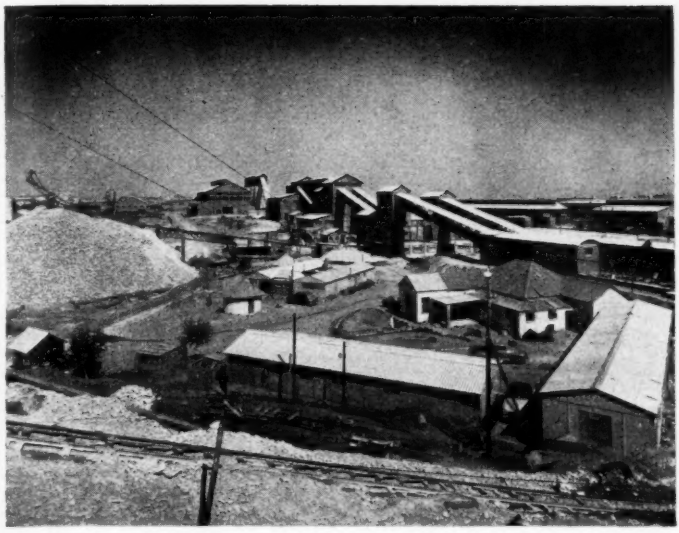
Ventilation

Although artificial ventilation was adopted in coal mines early in the 19th Century, it was practically unknown even 100 years later in metal mines. In fact it is almost exactly 50 years since the first metal mine in the world was fully ventilated by mechanical fans—namely, the East Rand Proprietary Mines in South Africa in 1908. Since then fans have become an essential item of equipment in most mines; as main fans for circulating fresh air throughout the mine, or as booster and auxiliary fans in various sections of the workings.

The principal reason for installing fans in coal mines was to provide air to dilute fiery gases, in order to reduce the risk of explosion. Metal mines are rarely faced with this problem and in the 19th Century had not reached depths where natural ventilation was unable to supply sufficient fresh air for the miners to work in reasonable comfort. As depths increased, however, rock temperatures rose and forced ventilation was needed to cool the workers, as well as to provide air for breathing. Another reason which was perhaps the most important in many mines, especially those on the Witwatersrand, was the recognition of the serious hazard of silicosis and in the fight against this good ventilation was a most effective weapon. There are, however, many mines with large airways, not very extensive workings, and no injurious dusts, where natural ventilation is still adequate.

The mechanical fans used by coal mines in the 19th Century were mostly backward-curved vane centrifugal fans. They ran at low speeds, driven by steam engines, and for large volumes and high water gauge were of large diameter. The largest had rotor diameters up to 50 ft. or more, their overall size being further increased by the volute casing. A distinguising feature of the backward-curving vane fan is its " non-overloading " characteristic.

By 1909 this type of fan had been made almost obsolete by the forward-curved multi-vane fan of the well known " Sirocco " pattern, developed by Davidson in 1898. This fan surpassed all other centrifugal fans



Surface Plant in Course of Erection, South Africa.

in output for a given speed and chiefly for this reason, notwithstanding the " increasing power " characteristic of the forward-curved vane fan, was used almost exclusively by mines for main ventilation from then onwards for many years.

About 1925 a backward-curved multivane fan was introduced which also had a high volume to speed ratio and this found widespread application in metal mines for auxiliary ventilation where resistances are apt to vary considerably owing, for example, to connexions being made between headings.

Later, aerofoil shapes were adapted to the blades, which improved the efficiency so much that this type of fan is, in certain circumstances, now competitive with axial-flow fans.

For metal-mine ventilation, the centrifugal fan has been superseded by the axial-flow or propeller type fan. Propeller fans originated in the 1890s but were not greatly used in mining, since, although capable of moving large volumes of air, they could operate against only low pressures (less than about 1 in. water gauge) efficiently. More interest was aroused in the type, however, when, about 1923, F. A. Steart of South Africa demonstrated that a number of aircraft propellers, mounted on the same shaft, was capable of working against higher pressures than was previously thought practicable for a propeller fan. From this developed multi-propeller fans, which were widely used in metal mines until the air-screw fan was introduced in the early 1930s. This axial-flow type of fan has shortened propeller blades bolted to a hub on the shaft of about half the diameter of the duct. For high pressures it is built in stages (a single stage will operate against 6 in. or 7 in. water gauge if necessary) and the blades may be fixed, adjustable, or variable. The latter features enable adjustments to be made to suit changing operating conditions. A typical single-stage fan of this type would be 120 in. in diameter, driven by a 200-h.p. motor at 366 r.p.m. It would have a duty of 250,000 cu. ft. of air per minute against a 2·5-in. water gauge. Fans of more than 200 in. in diameter and 400,000 cu. ft. per minute have been built.

The latest axial-flow fan is the turbo axial. In this, energy is transferred to the air in the form of kinetic energy of rotation instead of pressure energy, as in the conventional axial-flow type. This fan produces a higher pressure for a given peripheral speed.

Axial-flow fans possess a useful advantage that the air flow can be reversed by reversing their rotation—a simple matter with electric motor drive. They are widely employed for boosters and auxiliary ventilation underground. For the latter small fans with co-axial " built-in " motors of diameters 18 in. to 30 in. are normally used for insertion into duct lines of these sizes. Some types are

driven by an incorporated compressed-air turbine. Ducts of sheet steel or canvas are commonly used, but plastics and fibre glass are taking their place. These are light in weight, resistant to corrosion, and are made in rigid form for use in exhausting.

Venturi blowers, which originated in South Africa in 1923, are also used extensively for ventilating development ends and stopes. They are cheap and are easily installed wherever there is a supply of compressed air.

Air-conditioning plants for cooling and drying the circulating air in deep hot mines have been used for many years. The first was installed at the Morro Velho mine, Brazil, in 1920, followed in 1935 at the Magma mine, Arizona, and Robinson Deep, South Africa. A notable installation was at the Ooregum mine in the Kolar gold fields in 1938.

To reduce losses in airways due to leakage and wall resistance guniting has been used for many years. A recent innovation in this connexion is the use of a plastic "cocoon" sprayed on to cloth attached to the walls.

A landmark in the study of ventilation and health problems was the invention of the katathermometer before the 1914 war by Hill. Used for measuring the cooling power of air it was first applied to metal mining by Orenstein in South Africa about 1917 and is now a standard item of equipment in most metal-mining fields.

Surveying

The principal methods of surveying have changed little in the last 50 years. Triangulation and traversing are still the necessary preliminaries to map or plan compilation. The only major innovation has been the introduction of mapping from air photographs. Where large areas are involved this method is much more rapid and very much cheaper than any ground survey.

As manufacturing techniques have improved theodolites have become smaller, so that a modern precise instrument is often more compact than the older vernier instrument. This change is largely the result of introducing glass reading circles, which can be viewed by transmitted instead of reflected light. This ensures that the reading device can employ a much greater magnification. Some glass circles, only 3 in. in diameter, when seen through the magnifying reader have an apparent diameter of 15 ft. As a result a micrometer is no longer necessary in engineering theodolites, for the circle can be read by direct estimation to 10 seconds. Such instruments, called optical scale theodolites, will be employed for most engineering and mining surveys in the future.

In mine surveying a noteworthy development in the past 10 years has been the successful application of the gyro-compass for transferring the meridian underground. An accuracy of 20 to 30 seconds of arc can be obtained with these instruments. A drawback, however, is their high cost, which limits their use mainly to large mining groups. Small models have been used in the oil industry for surveying bore-holes not less than about 6 in. in diameter. It is likely that a miniature model will be produced that could be inserted in bore-holes as small as 2 in. or 3 in. in diameter.

Several self-adjusting levels are now on the market. With these instruments it is only necessary to set up and level approximately. The self-adjusting device ensures that the line of sight is truly level.

Ships at sea have for many years determined their position by reception of signals from three radio stations, but this method of distance measurement has only recently been introduced in land surveys. An easily transportable instrument for measuring distance directly by radio waves has recently been developed. Known as the Tellurometer, it can measure distances of up to 50 miles with an accuracy of one part in 300,000. This eliminates the principal difficulty in long-distance traversing. It is especially applicable in areas where triangulation is impossible. Unfortunately distances of less than 600 ft. cannot be measured reliably with this instrument, so that in its present form it has little application to underground surveying.

Almost all surveying calculations are now completed using some type of desk calculating machine and most mines possess several electrical or manually-operated machines that are used for surveying, accounting, and mine valuation.

Welfare, Health, and Safety

Probably no one feature of metal mining has undergone such notable change in the last half-century as has that of welfare. In 1909 it barely existed in the sense in which it is furnished to-day by all progressive mining companies, nor is it an exaggeration to state that the change has taken place mainly by the initiative of employers, rather than by pressure from employees or their Unions. For example, when change houses were first introduced many miners were reluctant to

A Northern Rhodesian Mining Township.

make use of them and even, in a few cases, to the point of going on strike. They were proud of their reputation of being tough and looked upon dirty working clothes as a symbol of their toughness.

Since metal mines were usually located in remote areas, and miners essentially pioneers who demanded few material comforts, mine welfare services generally lagged behind those found in more civilized centres and it is not without significance that even large mining towns, with all the amenities of modern life, are still often referred to as " mining camps ".

Advance in welfare services on mines was uneven if comparison of one country with another is made, for standards of living vary considerably with nationality. Mining companies, however, came to realize that a high standard of labour and efficient working required not only good wages but also good living conditions and at least a generation ago this change in outlook took root.

The rise of mining " groups," with large capital resources, was an important factor in the growth of welfare on metal mines, for they were well equipped for planning for the future and set high standards in housing, sanitation, hospital and medical services, and in recreation facilities, all of which are usually provided free or at only nominal charges to employees. The time is long past, for example, when a wood and corrugated-iron room and a camp bed was considered adequate accommodation for a worker on an established mine. The provision of such amenities as those mentioned above accounts for a large proportion, and may be as high as 25%, of the capital required to develop a new mine in many countries.

In other directions, too, there have been considerable advances in matters affecting the welfare of workers. For example, in 1911 the Silicosis Compensation Act in South Africa became law, as did also the Mines and Works Act in respect of safety, and about the same time came the first of the Workmen's Compensation Acts in the U.S.A., the latter largely at the instigation of the mining industry there. Apart, however, from satisfying legal obligations most mining companies have initiated their own pension and provident fund schemes for the benefit of their employees on retirement. This is a development that has become more universal in the last 20 years or so.

There has been much progress in the measures taken by mining companies to promote safety in mines. The larger companies usually employ safety engineers, whose duties include giving instruction in methods of safe working and of mine rescue and in education by means of films and posters relating to safety. Special working clothes—such as, hard-toe boots, shin guards, gloves, goggles, etc.—are insisted upon to-day in many mines and to ensure that they are worn are usually supplied at low or no cost to the workers.

A development of note that was initiated many years ago by some of the more progressive mines, and which has since been adopted by many, is the provision of underground lunch rooms where workers may eat a meal in clean and comfortable well-lit

surroundings. In a few mines, for example in Sweden, not only are such amenities provided but workers are encouraged to take a short rest on bunks installed for the purpose before returning to work after a break for a meal. Arrangements for supplying hot meals are sometimes included.

From being among the most backward of industries 50 years ago in providing welfare services for its employees the mining industry can now justly claim that for many years past it has been in the forefront in this respect. The point has been reached where this form of paternalism is demanded as almost a right by the worker and there is reason to doubt, despite the improved conditions, whether in some mining fields where such benefits are on a most generous scale that they have done as much as was expected to improve labour relations or working efficiency.

Scientific Management

Although, as has been recorded earlier in this resumé, much of the progress in metal mining in the last 50 years has been due to the introduction of electricity as a source of power and light, and to the use of better machines and materials, it was also mentioned that better planning and management were among the factors in this progress. In this the principles of scientific management have formed the basis of much of the conduct of mining operations, especially in the latter half of the period. Scientific management may be defined in its narrower sense as the process of planning for economy and setting standards of performance, but in its wider aspects includes the fields of labour relations and personnel management.

The foundations of scientific management were laid as long ago as 1881 by F. W. Taylor in the U.S.A., but although demonstrated by him and others —*e.g.*, the Gilbreths—that it was sound in principle and capable of effecting remarkable improvements in productivity of labour, the mining industry was slow, with a few exceptions, to put these new techniques into practice. Among his many achievements in this field, Taylor was able to increase shovelling efficiency at the Bethlehem Steel Works by 150% and F. B. Gilbreth in the building construction industry, to quote one example of his work, increased the number of bricks laid by one man in an hour from 120 to 350. Taylor pioneered time study and the Gilbreths motion study, the two components of work study.

The first documented application of work study in metal mining was by the Calumet and Hecla group of copper mines in Michigan, U.S.A., in 1911, followed shortly afterwards by other mining companies in the same area. The applications covered a wide field in underground operations, such as drilling, shovelling and transport, and considerable success was achieved in increasing efficiency. It was short-lived, however, for in 1913 the mines were closed down by a strike which lasted nine months, among the miners' grievances being the imposition of time studies on their work. Even to-day, when workers and Unions might be expected to be more enlightened, opposition to time study may still be a serious handicap to its introduction. Nevertheless, more and more mines came to adopt the system and before the outbreak of the 1939-45 war it was well established in metal mining in the U.S.A., South Africa, and parts of Europe.

Work study leads not only to higher efficiency but also to better planning, since programmes can be based upon accurate determination of performance and can thus be embarked upon with much assurance that estimates of cost, labour requirements, and output will be realized. It forms the basis, also, for the setting of incentive bonuses, which in themselves tend to increase efficiency, but which are generally necessary to maintain high levels of productivity.

Incentives, other than the size of the pay packet, affect labour productivity; among such may be cited status, pride in workmanship or work satisfaction, and a feeling of "belonging" to an organization. These are matters to which mine management, following the lead of other industries. is now giving more attention. The employment of personnel, welfare, and labour relations officers, and the rise in the number of mine "house magazines" in recent years, is an indication of this trend of thought in mine management.

The increasing use of machines has made their maintenance a matter of major importance. On most large mining properties to-day "scheduled maintenance", by which machinery undergoes predetermined maintenance checks and overhauls, is becoming a normal procedure.

On the financial side of mine management methods for the control of stores and working costs have been developed greatly in the past 10 or 15 years. "Budgetary Control" and "Standard Costing" or "Responsibility

Costing" are becoming well-known techniques for controlling expenditure and for estimating future capital requirements. Control is exercised by examining the differences or variance between the estimated and actual costs in the period. Standard costs are built up from work-study data and in responsibility costing costs are grouped according to the direct responsibility of the official concerned. Budgets are built up from low staff levels—for example, from that of mine captains—and in this way every official can be called upon to account for his stewardship.

For many years past training schools for mine workers have been a common feature on metal mines and since the last war instruction for supervisory staff has also been introduced on many fields. This usually takes to form of "Training within the Industry" (T.W.I.) a method developed in the U.S.A. during the war for rapid training of the many factory supervisors needed during that emergency.

Aptitude testing of new recruits is also a new development adopted by many metal mines in recent years, especially in Africa, where raw labour is mostly unfamiliar with modern civilization and its technical skills.

The last war also gave rise to "Operational Research", the analysis mainly by statistical methods of all available data for the purpose of determining the best action to take in the circumstances. The National Coal Board of Great Britain is applying these methods in the coal-mining industry and it would seem likely that some of the larger metal-mining groups in their various fields of operation will do likewise in due course.

The Future

The record of the past 50 years of metal mining is, as noted in this review, one largely of evolution of existing processes and no great fundamental changes in methods have taken place on an appreciable scale. There are clear indications, however, that this may not hold for the future and various changes in practice are looming on the horizon.

Among the more obvious of these is the probable use of underground nuclear explosions for breaking rock masses. This has proved practicable and two applications are at present receiving serious consideration in mining circles. One is the possibility of shattering an underground ore-body by this means, subsequently leaching the broken ore by solutions introduced through bore-holes. The pregnant solutions would then be pumped to a plant for extraction of the metals The other application is primary blasting of large volumes of overburden and ore prior to their removal by conventional methods of loading and transport. The economics of breaking rock in large masses by nuclear explosion appear attractive and the problem of control of radioactive particles and gases not unsurmountable.

Other methods of breaking rock *in situ* are also being developed and if successful may eventually relegate drilling and blasting to a secondary position. As already mentioned, machines for boring tunnels and shafts are already being used with success in the softer rocks and there is little doubt that in the next few years they will be perfected for use in the hard formations. Boring machines, using electrically-pulsed water jets, are reported under development in Russia and other methods, such as those employing ultrasonic pulsations, are also likely to be developed for use in hard rocks. Such machines, if successful, would eventually render obsolete present methods of handling rock for loading machines and hoisting in shafts would then be replaced by hydraulic transportation. In these circumstances the prime purposes of shafts would be for ventilation and transport of men and materials.

Advances of this kind in mechanization of mining operations will lead to automation, for these machines will be operated by remote control and will be designed to adjust themselves automatically to a change in the nature of the rock and to maintain a predetermined course.

In the meantime rock-drilling equipment will be improved in detail, lighter machines will perform heavier duties, and drilling costs will be lowered with new and better types of drill bits.

It can be expected, also, that changes in blasting practice will take place following research into the nature of rock breaking by explosives and the further development of new types of explosives.

The use of plastics in the construction of mining equipment will increase. Their qualities of lightness, strength, and resistance to corrosion suggest among other possible applications those for pumps, fans, ladders, truck bodies, and even cages and skips.

If metal mining has perhaps lost for the young engineer some of the romance and

adventure associated in the past with the winning of the metals of the earth in the remote and less civilized areas, it has gained much in the promise it offers in the further application of the results of scientific research and experiment to its technical problems in the future. The next fifty years will witness great advances in this direction and offer an exciting and rewarding life to those engaged in the profession.

The Sinking Record at Vaal Reefs

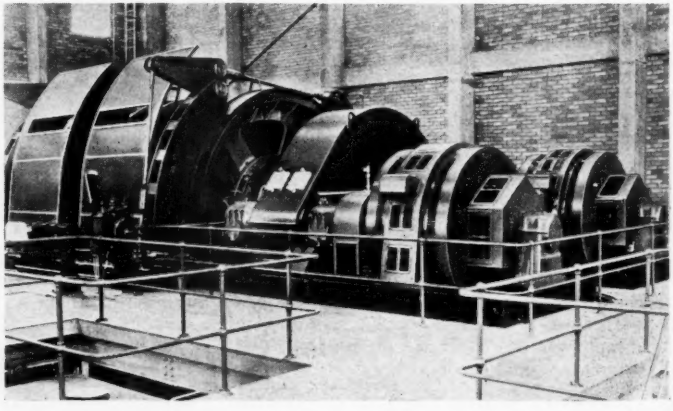
A brief account of operations and planning at this Rand mine.

L. A. Waspe

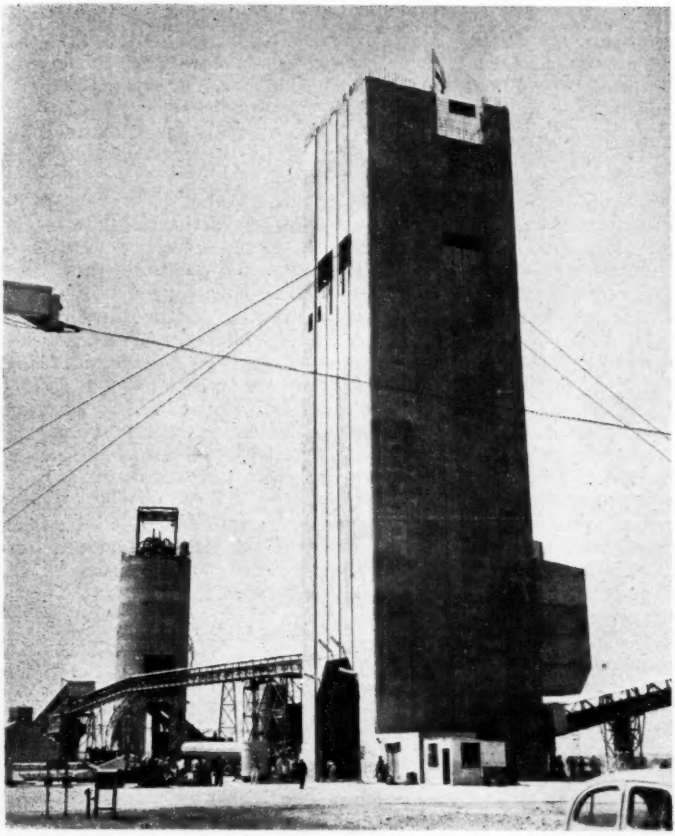
Vaal Reefs Exploration and Mining which in March, 1955, established a world monthly shaft-sinking record of 667 ft. in its 18-ft. lined-diameter No. 1 vertical ventilation shaft repeated that achievement with a rate of 922 ft. during September, 1959, in its No. 2 main vertical shaft, from 1,132 ft. to 2,054 ft. The formations traversed were dolomite, the Black Reef series, and Ventersdorp lava. Immediate preceding records were that of Soviet Russia—with an advance of 868 ft. in a circular shaft of the Don coalfield, 18-ft. lined-diameter and 21·65 ft. excavated diameter and that of Free State Saaiplaas, in the Orange Free State—with an advance of 834 ft. in a circular shaft, 27·5 ft. lined-diameter and 30–31 ft. excavated diameter. The next target for the record is stated to be 1,000 ft.

The Vaal Reefs company—in the Anglo American group—is exploiting a lease area of 6,828 claims in the Klerksdorp area and has to its west the Western Reefs mine, to its north, Zandpan, to its east, the Hartebeestfontein and Buffelsfontein mines, and to its south, the Vaal River. Immediately south of the Vaal River is the area of mineral rights held by Western Holdings, in which the Vaal Reef has been located at depths from 4,377 ft. to 6,593 ft. with values ranging from 1 in.-dwt. to 328 in.-dwt. and where, and further to the east in an area held by Free State Development and Johannesburg Consolidated Investment, further exploratory drilling is being conducted or is projected.

Reef development in the Vaal lease area has so far been confined to the Vaal Reef horizon (correlated with the Bird Series of



A.E.I. Sinking Winder at Vaal Reefs.



Vaal Reefs No. 2 Main Shaft and Bank.

the West Rand and the Basal Reef horizon of the Free State goldfield) in the western section. There operations have been conducted in the shallower mid-zone of an anticline with a north–south axis mainly from the Joint No. 3 Shaft (on the Western Reefs side of the common boundary with Vaal Reefs) and to a relatively limited extent from the No. 1 Shaft-system, about 8,000 ft. east of No. 3.

At Vaal Reefs the initial phase of production can be said to have been virtually completed with the sinking of No. 1 Shaft and the advance of development therefrom. The second phase—of consolidation and expansion—was initiated with the start of stoping in the No. 1 Shaft area and embraces also the extension of operations into the extreme south-western and south-central zones; south-eastwards towards the site of the No. 2 Shaft system, about 9,000 ft. from No. 1, and the sinking of the former, and northwards towards the Zandpan mine, the southern boundary of which lies about 7,500 ft. north of the northernmost workings in the Vaal Reefs mine.

Eastwards from No. 3 Shaft reef values were expected to decline and so far this expectation has been realized. Over the third quarter of 1959 the sampled footage and payability have averaged 505 in.-dwt. and annually backwards from and including 1958 this footage has averaged 416, 430, 567, 503, and 563 in.-dwt., with respective payability of 74·4%, 76·2%, 88·2%, 85·5%, and 86·7%. The indicated average bore-hole grade range was 220 in.-dwt. to 270 in.-dwt. approximately and payability 40% to 60% approximately. However, most of the drilling in the lease area was conducted at a time when no disclosures from actual Vaal Reef development were available and at best

the friable characteristic of the reef and consequent losses of values in borehole grinding, zonal fluctuations in values or mineralization, and their relations to what could be expected from actual reef development could only be estimated and speculated upon. In the case of Vaal Reefs, therefore, development values should consistently exceed those indicated by the boreholes. More recent drilling in the eastern section suggests that development values there should again pick up. The average depth appears to increase eastwards and, due to the anticline, northwards and southwards as well. Ore reserves, which at the end of 1956 averaged 10·38 dwt. over 38·9 in., or 404 in.-dwt., averaged 9·424 dwt. over 39·95 in. or 376·5 in.-dwt. at the end of 1958.

The gold plant, which treated about 50,000 tons monthly in the first period of production in 1956 with a yield of 7·54 dwt., and in the third quarter of 1959 treated about 80,000 tons monthly with an average yield of about 9·1 dwt., has been extended to a capacity of 100,000–120,000 tons monthly, will be expanded further to 125,000–150,000 by about 1962, and subsequently to 150,000–180,000 tons monthly. The projected expansion of treatment capacity, towards which operations will be advanced, should offset any decline in the mill grade and possibly the impact of tax and lease payments as well. The company should become liable for these payments from about the late 1960 or early 1961 period.

It is reasonably probable that in due course one or two additional shaft systems will be sited in the northern section of Vaal Reefs and that connecting haulages may be driven for ventilation and/or exploratory purposes into the neighbouring Zandpan property, as seems likely also to be done from the northern Western Reefs workings. The existing Vaal Reefs shaft systems comprise the Joint No. 3–No. 1 in the west-central section, consisting of 18-ft. lined-diameter vertical and subvertical ventilation components, and 24-ft. lined-diameter main hoisting vertical and subvertical components with an overall depth of about 7,300 ft. Sinking having been commenced early in the third quarter of 1959, the No. 2 system comprises a 20-ft. lined-diameter ventilation component and a 26-ft. lined-diameter main hoisting component, both to be sunk in a single lift to about 7,200 ft. The main shaft will have two rock–ore compartments, served by a Koepe winder installed on a platform at a height of 180 ft. in the headframe and hoisting two 14-ton skips at 3,600 ft. per min., two man-cage compartments served by a 5,200-h.p. double-drum conventional winder, at present used as the main sinking hoist operated at 3,000 ft. per min., and two service compartments. The shaft will be equipped with buntonsetts to be fitted at 20-ft. vertical intervals following the completion of sinking. The buntons themselves—designed by Mr. D. M. Bentley, a consulting engineer of the Anglo American Corporation—will be hollow steel, 12-in. by 6-in. flat-sided piping with rounded faces to the ventilation flow in order to reduce air resistance to a minimum. The headframe is of reinforced concrete, 44-ft. square box-section, at present completed for sinking operations to the Koepe winder platform level and to be extended eventually to a final height of 211 ft. A 140-ton headframe bin has been installed and a 1,200-ton waste storage-bin constructed which is fed by conveyor-belt from the headframe-bin and which itself discharges on to a conveyor-belt system terminating in a radial boom-spreader which forms the waste dump.

Sinking Data

No. 2 Circular Main Shaft.

Projected final depth.—7,200 ft. below collar.

Excavated diameter.—28 ft. to 29 ft.

Lined diameter.—26 ft.

Depth sunk.—September, 1959—922 ft. from 1,132 ft to 2,054 ft.

Depth lined.—September, 1959—940 ft.

Tons broken/hoisted.—September, 1959—52,500.

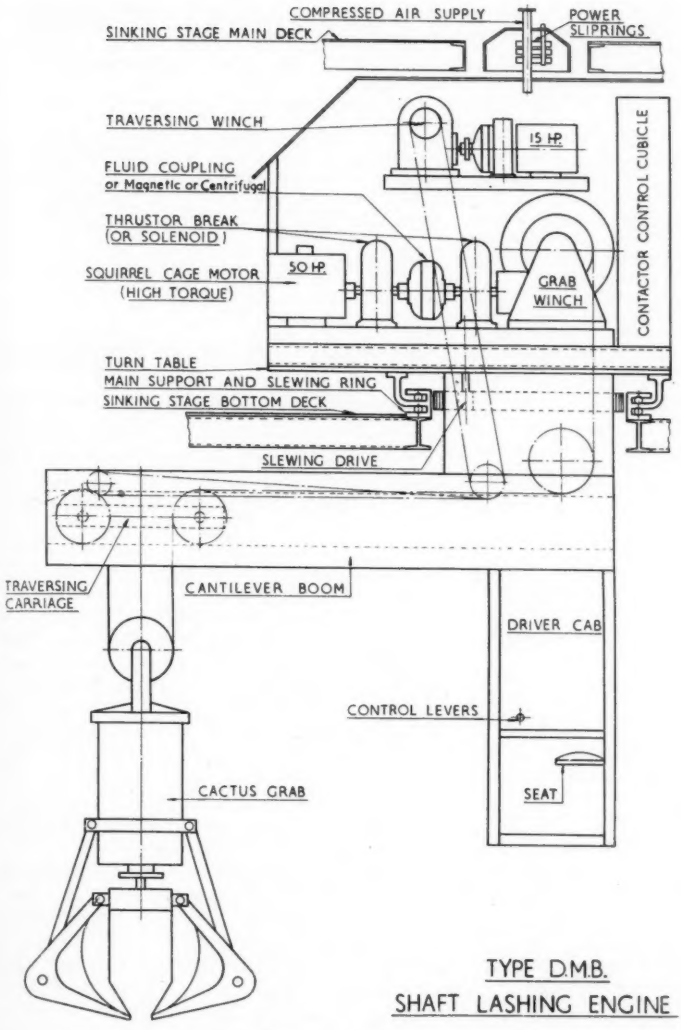
Rock disposal.—Four 10-ton kibbles are used in the sinking cycle and an additional two are held as standby. At the headframe the kibbles are tipped by means of lazy-chains, the broken rock gravitating through hydraulically operated swing chutes into the headframe bin, whence it is conveyed by belt to the storage bin and thence to dump.

Hoists.—For the sinking operations these comprise the 5,200-h.p. main sinking hoist; a 700-h.p. single-drum, electric sinking service hoist, and a Blair stage hoist.

Sinking stage.—This is a 6-deck Galloway sinking stage, the overall depth of the decks being 52 ft. The fourth deck from the top is movable in the 26-ft. interval between the third and fifth fixed decks by means of four chain blocks and tackle, mounted on the mobile deck itself and hand operated. The mobile deck provides access to the shuttering and facilitates handling of the latter, whatever may be the position of the stage required for rock cleaning.

Mechanical grab.—Designed by Mr. Bentley, mentioned above, this is a "DMB" 20-cu. ft. machine with a rated loading capacity of 240 tons per hour, equipped with an air-operated cactus-type grab. Patents have been applied for in respect of the drive mechanism and the unit will be available for export or fabrication abroad under licence.

Mounted on the sixth or bottom deck of the



Arrangement for Shifting Muck.

TYPE D.M.B.
SHAFT LASHING ENGINE

stage, the machine facilitates control of operations with the highest degree of simplicity and requires relatively little servicing and maintenance, whatever type of grab is used.

Three direct-on high-torque squirrel-cage motors provide the driving power for the three movements of the grab through shock-absorbing couplings of the traction-type fluid coupling (as used in the Vaal Reefs installation), or a magnetic coupling, or a centrifugal mechanical coupling. The radial traversing movement is facilitated by a friction-type rope winch driven by a self-locking worm and wheel, the rope passing over deflection sheaves to the traversing and rope-doubling carriage mounted in the cantilever boom. The radial prime mover is a 15-h.p. motor. Another 15-h.p. motor is used for the slewing or rotating movement, which is achieved by turning the whole machine (mounted on a ball-bearing course on the bottom deck of the stage) by means of a wheel and pinion. A 50-h.p. motor driving a rope-coiling winch raises or lowers the grab. (The attached drawing gives further details of the machine.)

For compactness, for providing protection against blast damage and falling water or concrete, etc., and to facilitate maintenance and servicing at all times the complete driving assembly, including the contactor control gear, is installed on a turn-table above the bottom deck of the stage and is covered by a canopy of steel plate. Another feature is the high-sensitivity earth-leakage protection for personnel and equipment. All the controls are

housed in the underslung driver's cab. Operations are effected at all times at virtually constant speeds.

Among advantages of the machine are the following :—

(*a*) Simple and robust drives with shockless motion.

(*b*) Ready and immediate access to the whole driving mechanism without holding up operations.

(*c*) Personnel and equipment are adequately protected.

(*d*) The design provides for the simplest possible operation under the confined, strained, and generally difficult conditions of shaft-sinking and reduces the requirements of skill to a minimum.

(*e*) With raising/lowering speeds invariable and being virtually the same the operation, apart from direct on and off switching, proceeds without interference from the driver. Previously raising was on clutch and lowering on brake, which in accelerated cycles gave rise to shock and damage to the equipment.

(*f*) Damage to the grab by dropping it fast into the broken rock, in order to secure depth of penetration, is eliminated. By easing the grab into the broken rock by moving the tynes wear and tear is reduced. Previously the wearing edges of the grabs, the radial arms motivating the tynes, the clutches and brakes, in particular, required an intensive level of maintenance and servicing often on a shift or cycle basis. In the Vaal Reefs operations this has virtually been lengthened to weekly servicing.

(*g*) With direct-on switching control has become in effect push-button.

(*h*) The balanced radial traversing movement calls for minimum power.

Drilling machines.—32 units 3⅛ in. bore ; frequency 2,600 blows per min. at 80 lb. per sq. in. ; air consumption 160 cu. ft. per min. at 80 lb. per sq. in ; equipped with drill-steel 1 in. by 108 in. and attached 40-mm. chisel-bit tungsten carbide bits.

Sinking round.—Each round consists of 170 holes in eight concentric circles with an average depth of 8 ft. The average advance per round was/is 7 ft. The average drilling time was 45–50 min. in September, 1959. Delayed-action electric detonators and 1¼-in. by 8-in. 60% gelignite sticks (11 per hole) were/are fired from surface. Fragmentation is reported as favourable, with broken rock ranging from about 1 cu. ft. down to the smaller sizes.

Cycles.—The nominal duration of each cycle was/is 6 hours. During the September month operations proceeded on a multi-cycle basis, 130 cycles being completed with an average duration of 5 hr. 32 min.

Lining.—Three ½-cu. yd. concrete mixers, each with a 28-ton silo, have been installed on surface. Rapid-hardening cement (2% cal. chloride additive) is batch weighed on surface with aggregate and gravitated through a 6-in. column to a 2-way distributor on the stage. Thence the concrete is delivered by two reinforced-rubber hoses to the face behind the shuttering which is moved in 20-ft. or 40-ft. lifts according to circumstances. The shuttering consists of eight rings of tubbing, each 2½ ft. deep with a perimeter of 81·65 ft., and is controlled by six manual davit winches, mounted on the top deck, and ½-in. chains with turn buckles.

Ventilation.—Four fans, each driven by a 110-h.p. variable-speed motor, are installed on surface and force air down two 30-in. diameter galvanized ventilation pipes to the shaft bottom. The overall rated capacity is 80,000 cu. ft. per min., of which 50,000 are presently being supplied for the sinking operations, with the balance to be made available for the initial development operations.

Pre-sinking treatment.—With the dolomite extending to a depth of 1,600 ft. in the No. 2 Shaft area one main cementation hole was drilled to 1,680 ft. and four supplementary holes were drilled to 200 ft. in advance of sinking to seal off water-bearing fissures. The pre-sinking cementation consumed 51,325 pockets (each 94 lb.) of normal Portland cement.

Sinking costs.—£69 per ft.

Labour.—48 Europeans and 470 natives.

Letter to the Editor

Radioactive Minerals in Southern Nyasaland

Sir,—I should like to give some information, additional to that contained in Dr. Bosazza's paper published in the August issue of the MAGAZINE, resulting from work undertaken in the Atomic Energy Division.

The radioactive minerals uraninite, davidite, allanite, betafite, monazite, sphene, and zircon were identified in our laboratories during 1956 and early 1957 and reports on these minerals were made available to New Consolidated Gold Fields, Ltd. This entailed much detailed work by our mineralogists, including radiometric assays as well as optical, autoradiographic, X-ray, and spectrographic studies. As long ago as September, 1956, for example, we drew attention to the similarities between davidite from Tambani and from Tete, Mozambique, in contrast with davidite from Olary, Australia—a feature which Dr. Bosazza confirms by differential thermal analysis. We also commented on the presence of two varieties of betafite—one brown-black, the other an amber-yellow alteration product—and showed that the unaltered material contained 20·8% eU_3O_8. Sphene we described as being only weakly radioactive and allanite as having an eU_3O_8 content of 0·1%. Later in 1957 we identified the secondary uranium minerals rutherfordine, soddyite, and curite from the Tambani area, but we have not observed samarskite in any material so far examined.

S. H. U. BOWIE,
Chief Geologist.

Atomic Energy Division,
Geological Survey of Great Britain,
Young Street Office,
Kensington, W. 8.
October 7, 1959.

Ore-Dressing Notes

(12) *Gravity Concentration*

Slimes Treatment (1)

Previous notes in this series have considered the principles underlying sluice action and connected them to gravity concentration on a shaking table. With properly-classified feed the movement of particles therefore responded in general terms to Newton's law :—

$$R = \pi \frac{r^2 \Delta v^2}{2} \qquad (1)$$

From turbulent motion, rapid settlement, and fairly heavy rate of feed per unit area to the other extreme brings in a variety of new factors. Movement under such conditions, with its gentle rates of fall and its particles sorted out by laminar flow or skin friction between them and the surrounding fluid, would accord broadly with Stoke's law :—

$$R = 6\pi\eta\, rv \qquad (2)$$

The important difference is that by equation (1) movement accords with $\sqrt{r}$ and by equation (2) with r^2. Again, very broadly, the extremely fine material which would behave in Stokesian fashion would do so too slowly for most economic processes, since there is a limit below which the weight of solids handled per unit area becomes too involved and costly to have practical value in a straight gravitational process.

In slimes treatment the important particle size is that of the band of material which is liberated between truly Newtonian and approximately Stokesian sizes. Such particles fall within the Allen zone, the governing equation being :—

$$R = Kr^n p u^{2-n} v^n \qquad (3)$$

In these formulae :—

v = velocity of fall.
R = Resistance to motion of a sphere.
η = Viscosity of liquid.
r = radius of sphere.
Δ = specific gravity of particle.
p = specific gravity of fluid.
n = coefficient of velocity.
u = kinematic velocity $\left(\frac{\eta}{p}\right)$

As it shades off at both ends the separating action may be thought of as almost Newtonian with the coarse fringe and almost Stokesian at the fine end. Only in the case of a mineral such as cassiterite, which combines a high specific gravity with a chemical inertness that makes it unsuitable for flotation, is it essential to push all-gravity treatment well into the sub-sieve range of particle sizes. Basing a practical comparison on characteristic feed rates and concentrating areas rather than on settling rates derived from the foregoing equations, a rough comparison could be tabulated as in Table 1.

Practice varies considerably both with regard to rate of feed and to size range fed to a specific type of gravity concentrator under stated conditions, but the generalization tabulated here is compiled from a cross-section representative of standard practice. From it certain basic principles emerge which must be accommodated into slimes treatment by unassisted gravitation.

(*a*) The horizontal area required varies inversely as the grain size of the feed.

(*b*) The area required is largely determined by the economic mesh-of-grind of the ore.

(*c*) Where all the ore is to be re-treated (tailings being re-ground, re-classified, and re-concentrated) the plant area needed for slimes treatment will be considerably greater than that for sands.

(*d*) Concentrating action must be progressively more gentle and free from mechanical shock, rippling, and exposure to wind as the finest limits are approached.

(*e*) Where the liberation mesh of the value is small extreme care in grinding and classification is an important factor in keeping the " break " (optimum mesh-of-grind) as near as possible to this mesh.

(*f*) Because of the increasing need for gentle action distribution of feed must be even, widespread, and so contrived as to minimize channelling.

Table 1

	Average lb./sq. ft. per hour feed.	*Particle size range.*	*Types of appliance.*
Newtonian . . .	60	20–200#	Shaking Tables.
Allen	30	150–400#	Slime Tables, vanners, buddles, round frames, strakes, racks, Buckman Tables.
Stokesian . . .	< 7	270#–30μ	

(*g*) Because formation of channels is almost inevitable and would lead to scour and loss the concentrating system must handle the problem these create.

(*h*) The concentration criterion (*C*).

$$C = \frac{M_h - 1}{M_l - 1},$$

where M_h and M_l are the densities of the heavy and light minerals respectively, must be adequate. At 200 mesh a ratio of 2·5 is adequate for particles of similar shape. Below 400 mesh—say, 40μ—that for cassiterite (S.G. 6·9) against silica (2·7) is 3·5 and is no longer sufficient to give crisp separation whereas that for gold (18·2) is almost 9, permitting good action providing an adverse shape factor (due to its malleable character) has not occurred.

(*i*) The coagulative-dispersive characteristics of the feed are important factors in influencing its tendency to remain open and hence responsive to gentle flowing action.

These nine operating considerations have influenced the design of the various machines used in slimes treatment. The main types of appliance include :—

(1) Slimes tables (vanners, gentle shaking tables).
(2) Strakes (sluices ; blanket, corduroy and rubber strakes).
(3) Continuous bands ("automatic strakes," corduroy and other belts).
(4) Racks ("ragging frames" ; automatic tilting frames ; Buckman tables).
(5) Buddles (bum-buddles ; dumb buddles ; concave and convex buddles ; continuous buddles).
(6) Round frames (revolving tables, convex and concave).

In connexion with this wide variety of sorting surfaces there is also some diversity of arresting material. Plain concrete, screened cement, and cement in which sawdust is incorporated is usually favoured in buddle work, while rubber, linoleum, aluminium, corduroy, and hairy blanketing are among the most-used catching deck materials. Some consideration of the specific appliances listed can be dealt with later.

E. J. P.

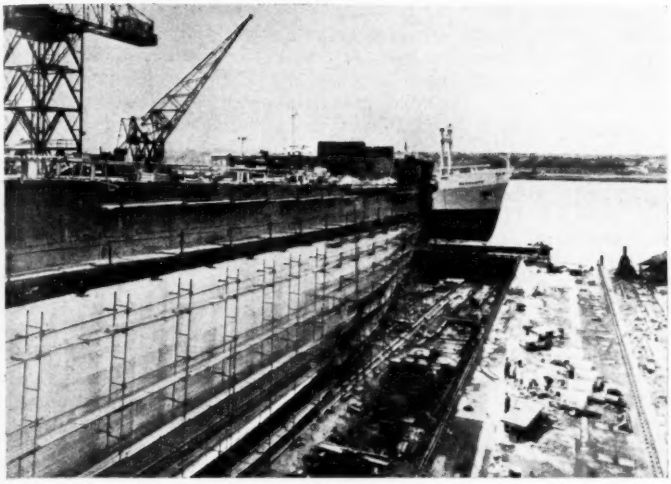
(13) *Testing*

Process Development

The common pattern of flow-sheet development is to start with fundamental research in the case of a comparatively unknown ore or one which is expected to present special problems. From this, through cycling testing, a process is worked up to the pilot stage. It is then transferred to the pilot-plant operation, where the main technical and economic variables receive evaluation. At this stage the important but rather tricky business of "scale-up" must be undertaken. It is not uncommon to find that in scaling up from the limited operation of a pilot plant with unusually accurate instrumentation and experience in the operational running, to the much less closely controlled business of putting large tonnages through the mill, working difficulties arise which were not envisaged in the original design. It is possible that ore dressing may be able profitably to borrow from a new technique used in chemical engineering called "evolutionary operation." This is described by G. E. P. Box in a paper entitled "A Method for Increasing Industrial Productivity in Applied Statistics (1957)" as "a method of process operation which has a 'built-in' procedure to increase productivity." He describes the application of this technique in a large chemical plant in the United States and finds that it has considerable value in improving plant running. Some of his points might be of interest to the ore-dressing engineer.

He makes the point that in the past the only statistical tool available for determining optimum conditions in a plant would be the same designed experiment used in the laboratory and in the pilot plant. To put a designed experiment right into a main production line involves risks which are frequently considered too hurried to be justified. If the process is limping along badly then some such "crash programme" may be forced upon the operator, but most flow-sheets are so nearly in good condition that the risk of upsetting production is worse than its cure of slight irregularity. It is in cases like this that the tuning-up of a plant to optimum efficiency can sometimes be set about by techniques based on evolutionary operation.

To quote again : "Biologists declare that there are two basic elements in the process of natural evolution, (1) variation, and (2) selection. . . . Because the variation and selection are ever continuing, the group gradually moves toward optimum characteristics. Evolutionary operation emulates this . . . by providing variation and selection artificially introduced." It is a permanent method of operation designed to push the process toward its optimum operating state. Because it is intended to be a permanent re-adjustment the techniques must be such as are easily understood by the operating



Ore Carrier Nears Completion.

personnel. Small changes only are made on two or three control variables. The effects of these deliberate changes in the variables will probably be masked by the usual large swings in production results, but since production is in any case continuing it is not significantly effected and by constant repetition and improvement of the small changes the quality of the whole flowline is gradually improved. In the chemical-engineering industry the second essential component is selection from the variations. This is done ideally by setting up " an information board." Study of the data gives first to the board and then to the process supervisor information as to how modification should proceed. Cyclic changes between tolerable drifts to both sides of normal can be re-located so that one of the drift ends becomes the new centre. Again the interval over which variables are examined can be changed. A path may be opened up leading toward improved conditions. Finally old variables may be replaced by new ones. It is recommended that if the programme to be carried has only two control variables an attempt should be made to add a third although two-variable programmes are best at the start.

In selecting the control variables which are to be examined the evolutionary operation committee has been found to be invaluable. Such a committee contains the process supervisor, a research chemist familiar with the work, and in the case of ore dressing an ore-dressing engineer with experience of the type of equipment and process used. The committee's function is to advise to the process supervisor as a result of regular meetings when ideas are discussed, examined, and framed into action. With such a committee actively in operation continuity of check of a flow-sheet is assured and new ideas are generated and brought into practical effect. Specialists such as an accountant, a statistician, or a person familiar with the quality required in the final product may be added as required to the committee. Although the term " evolutionary operation " is new no doubt many mill men will recall occasions in their working experience where they have been applying its principles to improve a well-established operation which has drifted somewhat. The thought here, as with that of working up a comparatively new and unknown process to fuller efficiency, is to have a set-up which ensures the best possible use of independent expert criticism in a regular way so that all ideas worth following up are attended to and seen through.[1]

[1] 43rd Annual Meeting, Technical Association of Paper Industry, New York, February 17–20, 1958. OLEHER, T. L. " Evolutionary Operation."

New Ore Carrier

Now nearing completion at the Hoboken, Antwerp, shipyard of Cockerill Ougrée is a new 33,700-ton bauxite ore carrier, which is being built for the Pan-Ore Steamship Division of A.L.C.O.A. International Corporation. With an overall length of 207 m.

(680 ft) the new carrier is a steam turbine-driven single-screw vessel and will be used for transporting bauxite ore from Trinidad or the Dominion Republic to the United States Gulf ports.

J. GRINDROD.

Molybdenum in Sierra Leone

Although small occurrences of molybdenum minerals have been reported from time to time in Sierra Leone during the past 20 years, it was not until 1951, the Colonial Office reports, that the Geological Department found more interesting deposits north of the Sierra Leone Development Company's Tonkolili iron-ore project, in the Lake Sonfon area of the Koinadugu District. First tests of the occurrence were disappointing, but in 1956, helped by a team from the Royal School of Mines, a geochemical survey was set up and this year two inclined drill holes have been put down to probe one anomaly to vertical depths of up to 450 ft. Cores taken from the holes contained enough molybdenum and lead minerals to support further drilling.

Faint indications of molybdenum are fairly widespread round Lake Sonfon and another team is to fly out from the Royal School of Mines next year to test stream and river water for molybdenum traces over an area of about 150 sq. miles.

Engineering Log

At Portland, Oregon, a continuous framing method of construction resulted in more rapid completion of a new 10-storey parking garage. Instead of the conventional style for multi-storey buildings, of columns which go through the structure from floor to floor, the beams are continuous over the top of each column. Each succeeding upper column tops the beam and a bolted connexion splices it. As a result steel weight is low at 109 tons, or 6·35 lb. per sq. ft., in the nine floors which are supported. Design of the building has been built around the new File-Away Parking System. This system incorporates a lifting device for supporting the wheels of cars, so that locked cars can be handled mechanically. Two building towers have been erected on either side of a slot that houses the two parking machines. These towers are each 90 ft. by 14½ ft. from centre to centre of columns and the cost of the steel frame was a modest $39,000. The main structural elements are the 12-in. beams and 10-in. girders and columns. In this system half of each of the column-beam connexions is fabricated in the shop, where beams are connected to the top of the one-storey columns by welding. Stiffener plates inserted between beam flanges are fabricated and ½-in. thick column seat plates welded to the top and bottom beam flanges. The resulting one-piece structural assembly is unusual. Site connexions involve both high-tensile bolting and welding processes. Columns are bolted to the top of beam flanges and shims inserted between bases of columns and column seat plates as required. Four-inch thick floor slabs are cast in place, the welded studs applied in the shop serving to tie concrete floor to steel frame. The erection has been designed to stand up under simultaneous earthquake and wind conditions under a full load. The two towers of the building are connected at one end by a concrete fire wall, at the other by a combination of horizontal and X bracer bars. Side walls are faced by means of vertical steel mullions and between the mullions is hung a curtain-wall grille made from expanded aluminium sheet. The expanded metal is 25% open, giving reduction in wind loads and providing ventilation while protecting parked cars from sun and rain. The end wall is faced with solid steel panels. Architects of the building are Edmundson and Kochendorfer, a Portland firm.[1]

* * *

The effect of changing industrial patterns on the world's climate is of considerable interest to science and that interest is by no means likely to confine itself to the remote observer in an ivory tower. One possibility of growing concern is a rise in temperature associated with increasing agricultural activity and release of carbon dioxide into the atmosphere. This gas operates by absorbing infra-red radiation which before to-day's exploitation of coal and oil escaped into space, but now produces something of a "greenhouse" effect. Our atmosphere is estimated to contain 0·03% CO_2, or $2{\cdot}3 \times 10^{12}$ tons. The oceans contain $1{\cdot}3 \times 10^{14}$ tons, mostly as carbonates and exchange about 2×10^{11} tons with the atmosphere annually. This dissolving-releasing action maintains a general

[1] *Engineering News Record*, January 8, 1959.

equilibrium in the system. Air and water gain CO_2 from volcanos, organic breathing, growth and decay, and rock weathering. With any change in these processes the concentration of 10% sorption and re-radiation of solar heat changes. During the past 10^9 years most of our planet has had a tropical climate with, about four periods of severe glaciation, each lasting a few million years. Study of ocean sediments indicates ten temperature cycles during the past 620,000 years. Calculations suggest that a halving of the CO_2 content of the air lowers the average surface temperature by 7° F. and is accompanied by freezing of from 5% to 10% of the sea as glacial sheets. This reservoir shrinkage in due course leads to an increase in atmospheric CO_2 and the cycle moves on to a sub-tropical epoch and a new organic demand. The observed data indicate a 50,000-year period for the complete cycle, though freezing and re-melting of glaciers are out of phase with CO_2 variation. In all this the photosynthesis of plants and their respiration balance out at about 6×10^{10} tons annually and the lock-up of carbon as fossil fuel takes up to 10^8 tons out of circulation. This is a big fall from the 10^{14} tons withdrawal during the carboniferous period which immediately preceded the most extensive glaciation known to geologists. Plants thrive in air rich in CO_2 and flourish at ten times the current concentration (a fact exploited by scientific florists). In past epochs the atmosphere was rich in gas now frozen in the earth. The 10^8 tons released annually by volcanos and hot springs is roughly equated by rock weathering. Any local change distributes its effects throughout the atmosphere so that geological reaction is world-spread. What is novel in the foregoing picture is the release of 6×10^9 tons of CO_2 annually by fuel burning and 2×10^9 tons of CO_2 by agricultural activity as grain replaces forests. It would seem that this new source also balances itself out in a few years by increased rates of growth and absorption by the oceans. Calculations show that during the past century we have "artificially" increased the CO_2 in the air by 13% and raised the average temperature 1° F. This is checked by known data. By the year A.D. 2000 the rise should reach 3·6° F. and 1,000 years from now, when known carbon-fuel sources are exhausted, the CO_2 content will have increased 18-fold.[1]

[1] PLASS, G. M., *Scientific American*, July, 1959.

The first trans-Atlantic telephone cable system, from the United States to Scotland, was laid in 1955 and 1956 and by the time it was ready for operation in 1956 the previously-used radio bands had become almost choked with messages travelling to and fro across the ocean. The new system came just in time. This year a second cable system was begun and this will be similar. The American Telephone and Telegraph Company, New York, reported that through European points, which will link U.S. networks with those of Belgium, France, Germany, Italy, the Netherlands, and Switzerland, it will be possible to reach 36 other areas. The new system will carry 36 voices simultaneously over a wire $\frac{13}{100}$ in. in diameter. One cable carries the voices to Europe, the other the answering voices from Europe, and both wires span a distance of 2,200 miles from Newfoundland to France. Heavy insulation will help the copper core to withstand the ravages of the Atlantic. In the deep water the insulated-cable section measures $1\frac{1}{4}$ in. in diameter and the shore-end section measures a little more than 3 in., giving extra resistance to tidal abrasion and the effects of ship anchors. The cables lie almost 3 miles deep in places. Conversations are kept separate from each other by the simple device of giving each a different carrier frequency and it is hoped later to double the capacity of the wire by means of an invention called TASI which is now under development. TASI will fill in the spaces on the wire caused by the caller's listening to the reply which is coming to him over the second wire. Deep-water laying of the cable began on March 14 and was twice halted, once for ice fields and once when a cable ship caught fire. The new system is estimated to have cost $40,000,000.

* * *

The post-hole digger has been mechanized on a giant scale by an American firm.[1] An auger is supported on a boom from a standard excavator and burrows down to give shafts up to 7 ft. diameter and 80 ft. deep in "bites" of $\frac{1}{2}$ ton to 1 ton at a rate of 20 ft. per hour. A metal lining can be lowered while drilling.

* * *

Russian engineers are now producing tubing in flat section which can be transported

[1] *New Scientist*, June 11, 1959.

in coils. They are of steel or aluminum with internal diameters up to 12½ in. On arrival on site they are straightened out and expanded to approximately circular section by compressed air at 8–10 atmospheres. The tube walls are ¼ in. to ⅓ in. thick.[1]

* * *

Emphasis has been placed recently on the possible usefulness of strontium-90 as a source of electrical power in remote stations throughout the world. At the Third Industrial Nuclear Technology Conference, Chicago, Dr. Jerome G. Morse, of the Martin Company's Nuclear Division, Baltimore, Maryland, pointed out that radioisotopes promise well as a source of electrical power, especially in unmanned operations. Power plants fuelled by means of radioisotopes are capable of long-lasting operation and a predetermined power output. Strontium-90 can be used in heat generators and converted to power. As a power source, having a half-life of 28 years, strontium-90 would not decrease materially its output over a period of from 5 to 8 years. An experimental programme now under way is expected to yield a safe and reliable power source using strontium-90 and requiring no maintenance. A generator will be designed to produce 100 watts of electrical energy for both land use and sea use. The land version will operate at 5% minimum efficiency, the marine version at 8% because of the superior heat dissipation by water. The element, whose central core of strontium-90 will be compounded into material with the least possible degree of solubility, will need a case of metal to protect it from thermal and physical shock and from melting. The electrical conversion system must match the strontium-90 in durability. Finally, the element must be incapable of ingestion or absorption by organic life under any circumstances and equipped with biological radiation shielding.[2]

* * *

A new mass spectrometer has been developed. This results from preliminary work in the National Physical Laboratory, the Services Electronic Research Laboratory, the Mond Nickel Co., and the United Kingdom Atomic Energy Authority. This instrument, the M.S.7, measures minute impurities in solid substances by spark ionization. It should be of considerable interest in engineering circles and metallurgy. Analyses have been successfully made down to 0·01 parts per million with the prototype model. These have been applied to uranium, high-purity graphite, germanium, selenium, silicon, gallium arsenide, magnesium, titanium, tungsten, iron, copper, and aluminium-tin and nickel-chromium alloys. Positively electrically charged ions from the sample are produced by a high-voltage spark between two electrodes of sample material placed close together in vacuum. The ions pass through an electrostatic analyser and then through a magnetic one and come into focus according to their mass, reporting as a series of lines on a photographic plate. A general picture of the impurities in a solid is given over the mass range of 7 to 240 and all the elements in this range can be recorded on one exposure of a photographic plate.

* * *

In recent years rotating evaporators and molecular stills have shown some disadvantages in the complexity of their construction. Rotating evaporators used directly as molecular stills have proved unsatisfactory either because the system is not capable of evacuation to the low pressure required or because if lubricated joints are involved the lubricant tends to contaminate the sample. Adaptation of this type of apparatus to multiple stages for distillation is a difficult matter. Molecular stills which use mobile films and an enclosed system are, however, not only complicated but also expensive in comparison with the rotating evaporators. It is therefore welcome news that the U.S. National Bureau of Standards has designed a simple rotating molecular still which can be constructed and operated with ease. It makes separation and purification with high boiling point materials possible rapidly, and at low temperatures, so that they are not exposed to severe thermal decomposition. The new still should be valuable for purification in biochemical and pharmaceutical work and in petroleum research. It has already been used successfully to remove colour impurities and high molecular-weight oxidation products from materials like the halogenated or alkylated dimethylenilines and similar anisoles. It has also been used to purify the high-boiling residues of crude chlorinated ethyl-benzene stocks. Chief requisites for the still are two

[1] *New Scientist*, June 11, 1959.
[2] *Science News Letter*, Oct. 3, 1959.

or more 500-millilitre glass bulbs connected in series, one or more glass ampoules, an infra-red lamp, a Dewar flask of refrigerant, and a motor to rotate the whole apparatus. The axis of the still is inclined about 10° from the horizontal. At the higher end is placed the glass bulb containing the sample. The remaining bulbs collect the distillate. At the lower end are placed the glass ampoules in which the distillation fractions are bottled. The motor turns the still at 1–2 r.p.m. As it rotates the test sample forms continuously a surface film on the container wall. This film is heated by the infra-red lamp and molecules evaporate from its surface. The bulk of the test sample remains cool. The vapour gradually flows to the bulb next to the sample-containing bulb, where it is condensed by means of a wide-mouthed Dewar flask, containing liquid nitrogen or a slurry of solid carbon dioxide in carbon tetrachloride and chloroform, and placed immediately beneath the collecting bulb. Repeated distillations can be made by simply moving lamp and flask to adjacent bulbs in succession. After melting the distillate is drained into a glass ampoule. The ampoule is then sealed and removed. The new still was designed at the National Bureau of Standards by G. S. Ross and L. J. Frolen.[1]

News Letters

BRITISH COLUMBIA

October 14.

Placer Development, Ltd.—The annual meeting of Placer Development learned from the company president, Mr. John D. Simpson, that its wholly-owned subsidiary has already spent more than $500,000 in the joint programme, in company with Noranda Mines, Ltd., and Peerless Oil and Gas Co., Inc., in the development of the Merritt district property of Craigmont Mines, Ltd. The company is well pleased with the results of the work and anticipates early announcement of production plans, locally rumoured to be on the scale of 4,000 tons daily. Mr. Simpson said the property of Mattagami Lake Mines, Ltd., in northern Quebec, was also responding favourably to development, with indicated ore reserves of 20,800,000 tons grading 0·018 oz. of gold and 1·31 oz. of silver per ton, and 0·68% copper and 12·76% zinc in the No. 1 ore-body, with 1,700,000 tons assaying 0·013 oz. of gold and 0·99 oz. of silver per ton and 0·86% copper and 12·82% zinc in the No. 2 ore-body. Placer Development holds a one-third interest in the operating company.

The sale of all Placer's interest in Coronet Oil Company (Texas) on July 16 netted $12,190,437 (U.S.), a sum which was immediately converted into $11,200,000 (Canadian) and invested in Canada Treasury Bills and short-term Government of Canada bonds to earn an average of 5·55% yield per annum.

In commenting on the operations of subsidiary and associated companies Mr. Simpson said the Jersey lead-zinc mine of Canadian Exploration had earned a net operating profit of $41,779 in the four months to August 31 after provision of $120,600 for depreciation. The company is active both on its own account and in partnership with other companies in the exploration field throughout Canada.

The president reported that mill testing of ores of the Montana open-pit gold property of American Exploration and Mining Co. has produced satisfactory results. Ore reserves are estimated at 16,000,000 tons and it is calculated a small profit can be made at the present price of gold. However, production plans are being held in abeyance. Examination of the Marinduque project, in the Philippines, continues and 25-year leases with options of 25-year renewals have been obtained by the owners. More geological information will be required before the property can be fully assessed.

The Evan Jones Coal Co., in Alaska, in which American Exploration owns a 48¼% interest, had an exceptionally good year, the net income for that ended July 31, 1959, being $331,907, as compared with $151,240 in the previous fiscal year.

In Australia the Foybrook-Newdell operation continued on a single-shift basis in the four months to August 31, producing 80,303 tons of washed coal. Sales in that period were 84,535 tons, of which 36,800 tons were exported. At the Gilmore lode-tin mine, in North Queensland, limited production has been maintained concurrently with geological examination. Future operation will be dependent upon the favourable development of a new lower level.

In discussing the associated companies, Mr. Simpson said Pato Consolidated Gold Dredging, in Colombia, has reported an estimated net profit of $300,000 for the first six months of 1959.

Queen Charlotte Islands.—Silver Standard Mines, Ltd., is preparing to place its high-grade magnetite properties at Harriet Harbour, on Moresby Island, in production as quickly as possible. Ore reserves, sufficient to produce well in excess of 1,000,000 tons of concentrate, have been indicated by a thorough pattern of diamond drilling and recent holes have suggested substantial extension. The ore grades slightly above 50% iron, with negligible quantities of sulphur, titanium, and phosphorous.

Wesfrob Mines, Ltd., wholly-owned subsidiary of Frobisher, Ltd., has developed a high-grade iron deposit at Tassoo Harbour, on the west coast of Moresby Island. An indicated deposit in excess of 5,000,000 tons grades almost 60% iron with nearly 2,000,000 tons also containing close to 1·5% copper. The company is prepared, according to a statement by the president, to commence production as soon as the British Columbia Government takes a more tolerant attitude toward ore export.

Vancouver Island.—The "iniquitous" iron-ore taxation policies of the British Columbia Government were severely criticized by shareholders at the annual meeting of Quatsino Copper-Gold Mines, Ltd. The company president informed the meeting that not only had taxation proved a dreadfully cumbersome burden, but that the operation of

[1] *Comp. Air Mag.*, Aug., 1959.

Empire Development Co., Ltd., in which Quatsino holds more than 40%, had been compelled to bear the entire cost of $1,500,000 for road construction to connect the Merry Widow mine with tidewater at Port McNeill. Empire has been successful in renegotiating a sales agreement with Japanese interests to net the company some $1·50 more per ton of concentrate during the next three years.

Freight and treatment charges on copper concentrate shipped by Cowichan Copper Co., Ltd., to Mitsui and Co., Ltd., and Sumitomo Shijo Kaisha, Ltd., will be reduced by $2·00 per metric ton of 2,204·6 lb. during 1960. The saving is estimated to mean $1,400 greater net revenue on the basis of shipment of 700 long tons monthly.

Lower Mainland.—The company president and a director of Taiga Mines, Ltd., are at the moment in New York seeking major financing to initiate production from the company's promising germanium deposit at Powell River. Proposals have been received from major exploration groups and notably from a leading electronics manufacturer interested in obtaining an assured supply of the scarce metal. Dr. A. C. Skerl, the consulting geologist, has estimated a developed reserve of 100,000 tons of ore, valued at $35 per ton and containing a total of 10 tons of germanium. Dr. Skerl states that the potential is impressive and concludes it should be possible to prove a great deal more ore while pursuing the necessary research on a satisfactory milling method.

Greenwood.—Shareholders of the Continental Mining Corporation, at an extraordinary meeting on September 15, approved a proposal for liquidation of the company and acceptance of one share in "Continental Consolidated Mines, Ltd." for each three of Continental Mining surrendered. The new company has also acquired all holdings of Columbia Copperfields, Ltd., whose shareholders have, however, been more magnanimously rewarded, with one share of "Consolidated" for each share of Columbia surrendered. The combined holdings are all situated at Phoenix and it is proposed to initiate mining in the near future if satisfactory arrangements can be effected for custom milling of the ore in the vicinity.

Rossland.—The annual meeting of Mid-West Copper and Uranium Mines authorized an increase in the company's capital structure from 4,000,000 to 5,000,000 shares of a par value of 50 cents each. During the past year the company has effectively reduced its outstanding debt and at the same time has reclaimed and rehabilitated the Velvet mine and mill at Rossland to the point where the production of copper concentrate was again started on September 1. A recently-discovered replacement orebody at the horizon of the 7 level is providing an abundant supply of good-grade ore at the outset. Some interest has also been aroused through the discovery of platinum metal in samples of the ore.

Princeton.—Blue Star Mines has acquired five placer leases on platinum-bearing gravels covering 400 acres of old bench along the Tulameen River. The presence of platinum has been known for many years and a number of geological reports have been compiled. Sporadic efforts at recovery on a small scale have proven unsuccessful. Blue Star has entered into a partnership with Kumhila Explorations, which company has agreed to place a dragline dredge and floating washing plant on the property. Mr. Dudley L. Davis, a well-known mining engineer with extensive placer experience, is in charge. Blue Star is continuing its underground development of the Wellington and Star silver-lead mines at Retallack.

Golden.—The annual meeting of Sheep Creek Mines approved an increase in authorized capital from 2,000,000 shares to 3,500,000 shares in order to provide working capital, if required, to carry out full production plans for the very promising La Reforma mine in Mexico. The company president, Mr. J. R. Pyper, told the meeting that an underwriting at not less than $1 a share was already assured on the additional shares if such evidence of performance would be required by the Mexican authorities. At the same time the managing director, Mr. H. E. Doelle, assured the meeting that no attempt would be made at preparation for production unless the full co-operation of the Mexican authorities was obtained in writing. A further property payment of $375,000 remains to be made. The Sheep Creek company currently has working capital in excess of $700,000. La Reforma reserves are estimated in excess of 1,250,000 tons, grading 6 oz. to 8½ oz. silver per ton with 1% copper, 5% lead, and 13% zinc. Tentative arrangements have been effected with custom smelters in Oklahoma and in Mexico for refining of the product of a projected 500-ton concentrator. The company's amazing Mineral King mine, at Invermere, continues to earn an operating profit despite depressed prices and restricted markets. In the quarter ended August 31, 1959, a net profit of $81,269 was earned after treatment of 48,091 tons of ore.

Alaska.—The Northern Industrial and Development Co., Inc., is well advanced with drilling of the tide flats at Skagway, preparatory to the construction of a projected smelter for the treatment of custom ores from Alaska, Yukon, and northern British Columbia. The company is headed by Mr. R. Crowe-Swords, of Vancouver. A participation is held by the Waddington Mining Corporation, Ltd., a Dominion incorporation, and the Natural Resources Syndicate, Ltd., a private British Columbia company, both of which are also headed by Mr. Crowe-Swords.

EASTERN CANADA

October 28.

Gold Production.—The output of the gold mines of Ontario for July included 221,814 oz. of gold and 32,172 oz. of silver, valued at $7,498,030, from 774,749 tons of ore mined. In August the 683,819 tons treated yielded 191,598 oz. of gold and 29,141 oz. of silver, worth $6,428,545.

North-Western Ontario.—In the first half of the current year MacLeod-Cockshutt Gold Mines, one of the lowest-grade gold mines in Canada, earned a net profit of $158,474. Output for the period is valued at $1,111,540 and, with cost-aid added, to $1,262,322. The company is now preparing the ore-bodies on the adjoining fold properties owned by Consolidated Mosher Mines for full-scale production. It will take about two years, it is thought, to develop the property to the point where it will sustain a 2,000-ton-per-day mill rate.

The erection of a 100-ton-a-day pilot plant has been started by Anaconda Iron Ore (Ontario) at its iron property near Nakina. Expected to be complete during the coming winter the plant is to be used to settle the final flow-sheet. Work to date has outlined over 200,000,000 tons of open-pit ore

in two separate ore-bodies. The ore is described as a clean magnetite grading 28 to 30% iron.

Sudbury.—In the Steep Rock area Canadian Charleson, Ltd., expects to ship some 170,000 tons of iron concentrates this season. The company's concentrator treats about 450 tons of gravel per hour grading from 5 to 25% iron; concentrates average around 58% iron. The estimated reserves exceed some 50,000,000 tons on the 1,450-acre property. The company, which began operations last year, is a wholly-owned subsidiary of the Charleson Mining Company, of Hibbing, Minnesota.

Saskatchewan.—It is announced that the Provincial Government has entered into an agreement with the Knox Saskatchewan (1957) Syndicate to explore for minerals in the area north of La Ronge and west of Reindeer Lake, in the Rottenstone Lake mining district. The agreement, it is stated, calls for prospecting and development work to be carried out over three periods of one year each, at a minimum expenditure of $300,000 for the three-year period ending May 31, 1962. This expenditure can include ground and aerial geophysical work, geological work, drilling and mining, or any work deemed necessary to prove the area.

The accounts of Rix-Athabasca Uranium Mines for the nine months to September 30 show a loss of $53,000. In the period 40,287 tons of ore were sold.

Manitoba.—In the three months to June 30 last, Sherritt Gordon Mines made a profit of $704,728, which brings that for the first half of the current year up to $1,164,226. It is thought that increased capacity arising from mill expansion at Lynn Lake will soon permit the treatment of a larger tonnage of ore and increase the supply of concentrate to the Fort Saskatchewan smelter.

A new shaft to develop the Forty-Four Mines property is to be started by San Antonio Gold Mines, Ltd. The main haulage between the properties is nearing completion. The new shaft will be put down from the 3,800-ft. level of the San Antonio mine. Officials of the company have been actively searching for outside properties, it is stated, and at the moment prospects look good for the continuation of operations at the San Antonio camp.

The Hudson Bay Mining and Smelting Company reports a profit of $4,401,388 for the first half of the current year.

Quebec.—Consolidated Vauze Mines, it is stated, which owns a base-metal prospect covering 2,840 acres in Dufresnoy and Duprat townships being developed by the Consolidated Zinc Corporation of Canada plans a vertical three-compartment shaft. This will probably be sunk to a depth of 800 ft. with the first level to be established on the 600-ft. horizon. Diamond drilling has outlined an ore-body about 420 ft. long and averaging 11 ft. wide down to a depth of 500 ft. This zone is estimated to contain some 80,000 tons or ore grading 6·5% copper, 4·5% zinc, and from $2.00 to $3.00 gold and silver per ton.

A hole put down on the property of Quebec Smelting and Refining at a point about 1¾ miles from, and on strike with, the Opemisca showing, has intersected a 141-ft. section of continuous mineralization. Low gold values have been found from 305 to 446 ft. Within this 141-ft. section, two sections gave higher-than-average gold and silver. A 3·5-ft. section returned an average gold content of 0·19 oz. per ton and an average silver content of 0·55 oz. per ton. A second section of 12·5 ft. averaged 0·20 oz. of gold per ton.

AUSTRALIA

October 20.

Iron Ore.—The intensive search for iron ore in Australia continues, but a recent statement is to the effect that the occurrence being tested by the Broken Hill Proprietary Co., Ltd., at Iron Range, on Cape York Peninsula, Queensland, is unlikely to contribute any large tonnage of good ore, although exploratory work is, however, to continue.

The Western Australian State Government has approached the Commonwealth Government for permits to export iron ore from two deposits, but the request has been refused and the Government has decided to retain its 21-year old embargo on the export of iron ore from Australia. This was the second request in two years by the Western Australian Government for relaxing the export restrictions and in each case the application has been refused. It would, therefore, seem unlikely that similar requests will be made in future.

Oil Exploration.—The partners in West Australian Petroleum Pty, Ltd., have decided to continue the search for oil in Western Australia for at least another three years. Expenditure to date by this organization has been more than £15,000,000 and it is expected that another £15,000,000 may be spent in the next three years. There is confidence that the new well about to be commenced, Thangoo No. 1, 50 miles south-east of Broome, may provide geological information which will help in solving the puzzles of the salt dome encountered north-east of Broome and also the traces of oil and gas found in recent wells in the Kimberley country. The company proposes to commence off-shore submarine exploration in Exmouth Gulf, north of Rough Range, where flow oil was found in 1953.

West Australian Petroleum is also considering drilling at Barrow Island, north of Exmouth Gulf, the object of these operations being information bearing on the problem of the Rough Range discovery of oil.

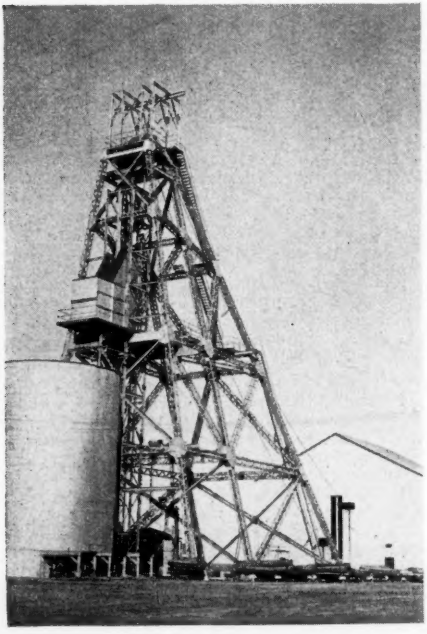
Work is being continued on the Queensland–South Australian border, at Innamincka, and in North Queensland, where Associated Freney Oil Fields has been granted a subsidy by the Commonwealth Government to drill on the Cooroorah anticline which is described as an attractive structure.

Diamond Drill.—Mindrill, Ltd., has made, assembled, and tested what is described as the largest diamond drill in the world. The drill, capable of reaching a depth exceeding 10,000 ft. and using a bit 2½ in. diameter, has been made for Kalgoorlie Southern Gold Mines, which is drilling the country south of the Golden Mile, Kalgoorlie, Western Australia, with the object of locating repetitions of the Golden Mile beds. This is one of the most interesting exploratory operations in Australia at the present time. Shareholders in Kalgoorlie Southern include some of Australia's largest mining companies.

Mine Electrification.—Electrification at Kalgoorlie has been proceeding steadily for some years, so that at the present time electric power has practically superseded steam. The last stage of conversion on the mines has been that of the winders. Lake View and Star has almost completed the change over at Chaffers shaft and Great Boulder Gold Mines has finished the transition at Edwards shaft. This last is the first stage of a £A265,000 development programme and the cost of the Edwards shaft

electrification is £A105,000. The new winder comprises a 1,000-h.p. Metropolitan-Vickers motor geared to the existing drum shaft of an Australian-made Thompson steam winder which has hauled 7,000,000 tons of ore up Edwards shaft since 1906. It includes new features in control and safety devices. It is intended to electrify Hamilton shaft at a similar cost and a new power unit to meet the additional load has already been installed. The new winding equipment will leave the United Kingdom in November and be erected by March, 1960. The Hamilton shaft is 3,250 ft. deep and Edwards approximately 3,000 ft. An internal shaft is being sunk from the 2,950-ft. level and is now below the 3,400-ft. horizon. The ultimate depth will be 1,000 ft. below that level and sinking cost is about £A100 per ft.; the present objective is a depth of 4,000 ft. A main haulage way now connects Hamilton and Edwards shafts at the 3,100-ft. level and ore mined below this horizon will be hoisted through the internal shaft, transported along the 3,100-ft. level, and hoisted to surface through Edwards shaft. Development will be carried out from the internal shaft, as sinking proceeds, and results will determine the depth to which this shaft will be sunk.

Northern Territory.—There is interest in the Peko Copper mine at Tennant Creek, as the Territory's only copper mine. In recent months there has been a marked fall in grade with depth and a corresponding fall in profits. Total ore reserves are estimated at 1,000,400 tons, with an average grade of 6·3% copper, which compares with an estimated tonnage of 1,017,300 tons, with a grade of 6·71% copper in the previous year. The estimated reserves are made up of 636,400 tons of proved ore with an assay value of 7·5% copper and 370,000 tons of indicated ore with a grade of 4·3% copper. The company has stated that ore reserves will not permit a greater rate of extraction.



Ivanhoe Shaft, Lake View and Star.

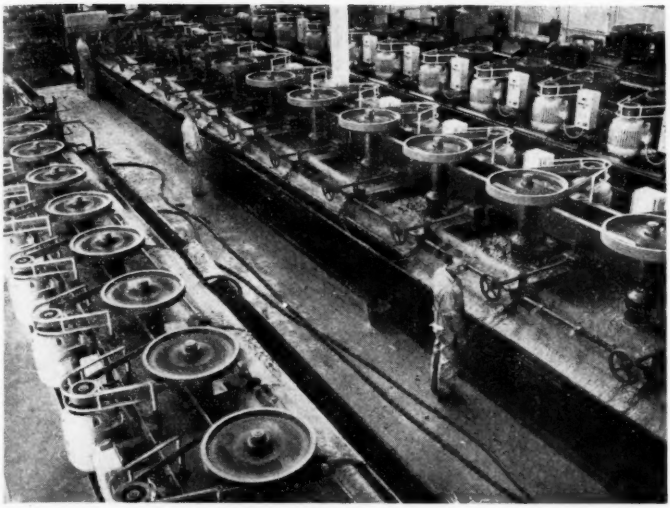
The company's future could be greatly helped if arrangements could be made with Mount Isa Mines to smelt Peko concentrates in the Mount Isa copper smelter, which is being enlarged to cope with the increased output of that mine. Such an arrangement would mean a large saving in transport charges on concentrates to smelters on the east coast of the continent as at present.

Mount Lyell.—The operations of the Mount Lyell Mining and Railway Co. for the year ended June 30, 1959, resulted in the removal of 3,900,000 tons of material from the West Lyell open-cut, tonnages of ore and waste being approximately equal. Ore delivered to the mill was less by 68,000 tons than in the previous year, owing to difficulties with the old ore transfer pass and delay in completing the West Lyell crushing and transport system, which was not in full commission until May. That system is now working, but some modification may be effected to give full efficiency and maximum capacity. Average grade of ore treated was 0·652% copper and 10,000 tons of copper were produced. Tonnage in the current year will be the same as last year, but grade will be slightly higher.

The target for the current year is 11,000 tons of copper concentrate, the highest for many years. Additional waste must be removed in the period, which will be reflected in costs. A new method is to be introduced in open-cut working. A "drop cut" from the 1,320-ft. level is to be commenced to develop a lower bench to supply a considerable tonnage of the milling ore during the year. The open-cut will become a true pit with no level entrances to the benches from the surrounding hillside. Successive drop cuts will eventually develop eight benches to reach the projected bottom 360 ft. below the 1,320-ft. level.

Diamond drilling within the company's leases is reported to have been rather disappointing, due to the location of pyrite in places where copper ore was hoped for. However, further downward extensions of the West Lyell ore-bodies were proved. The ultimate depth of these ore-bodies has not yet been reached, but ore has been discovered 1,500 ft. below the final bottom of the open-cut as planned at present. These ore-bodies are continuations of those previously referred to by the chairman last year, as containing 50,000,000 tons of ore, with an average value of about 1·0% copper. The method of working is being planned, so this tonnage is not yet included in ore reserves. Diamond drilling has been temporarily suspended, but prospects of finding rich ore underground are considered good and drilling will be resumed.

The company's annual report refers to the exploration of a higher-grade occurrence in the Corridor area by tunnelling from the Crown Lyell mine, for which purpose the Crown Lyell shaft has been reconditioned and the North Lyell tunnel re-opened. The Lyell company, in conjunction with the Electrolytic Zinc Co., has made active geological and geophysical exploration of the south-west corner of Tasmania. In the Moore Valley an anomaly has been located which will be investigated by drilling and a route is being explored for transport of machinery.



Flotation Machines in a Broken Hill Mill.

(Australian News and Information Bureau.)

Bauxite.—Prospecting for bauxite continues prominently in Australian mining. Comalco is pushing on with the exploration and development of the Weipa deposit on Cape York and expenditure has exceeded the minimum required under the agreement with the Queensland Government. In addition to the expenditure on the Weipa bauxite deposits the company has spent a large sum on examination of the Blair Athol coalfield and further expenditure has been incurred overseas in investigations of harbour possibilities.

In Western Australia the Western Mining Corporation has been joined by North Broken Hill and Broken Hill South in prospecting for bauxite in the Darling Ranges. This policy of association may continue if other prospects are obtained which might get beyond the initial state. Western Mining Corporation would, however, retain the management of a high proportion of the prospects initiated by that company. Drilling has commenced on Western Australian bauxite areas, but some time must elapse before any conclusions can be reached.

Victorian Gold.—The State of Victoria, once a leading gold producer, will now be reduced to two producing gold mines, with the pending closing down of Morning Star (G.M.A.) at Wood's Point. The two remaining operating companies are Wattle Gully Gold Mines and A. L. Consolidated. Morning Star has had a life of close on 100 years, under various controls. Several unproductive zones were met in working, which caused cessation of mining, followed by re-opening. The last re-opening was by Gold Mines of Australia which has spent £A429,000 in a period of eight years with unfavourable results. Diamond drilling cut several reefs below the No. 19 level and an internal shaft was sunk for their exploration. These reefs, however, proved to be small and after considerable exploration down to No. 24 level the company has decided that there is small prospect of locating reefs of economic value between Nos. 19 and 24 levels.

The big fields of previous years—Bendigo, Ballarat, Daylesford, and others—are idle. Prospecting is practically dormant, except by Gold Mines of Australia on the old Stawell goldfield, where operations are reported to have outlined a gold-bearing area of commercial possibilities, contingent upon the price for gold.

The Wattle Gully mine is the leader of Victoria's two remaining gold mines and continues a remarkable operating record. In the year to June 30, 1959, the mine treated 50,894 tons of ore for the recovery of 19,097 oz. of gold, an average grade of 6·37 dwt. In the previous year tonnage treated was 56,732 tons and gold recovered was 21,285 oz., an average of 7·46 dwt. Ore reserves were estimated at 215,710 tons with an average grade of 6·2 dwt. The previous year's estimate gave a total of 223,500 tons with an average value of 7·2 dwt.

Central Norseman.—Developments at the Central Norseman mine continue to be very satisfactory. Ore of higher grade than normal was milled in the period 1958–59, which reflected on the profit. The chairman has pointed out that continuance of this profit level depends upon meeting, from time to time, unusually rich patches in the lodes. New ore-shoots must either be found at greater depth or laterally from existing workings. Two diamond-drill results, which did not actually disclose payable ore, were significant in the longer-term search. One was the intersection of a quartz vein in the foot-wall of No. 27 level, indicating deep mineralization in the Crown shear. The other was a hole in depth in the Princess Royal mine, which gave the first indication of a recurrence of deep ore.

Great Boulder Gold Mines.—A preliminary report on operations at Great Boulder in the year ended June 30, 1959, gives the following figures: Ore treated, short dry tons, 507,006; gold recovered, 124,684 fine oz.; silver recovered, 32,678 fine oz.; head value of ore, per short ton, 5·38 dwt. gold; bullion proceeds, £A1,961,017; net profit from all sources, £A274,113; ore reserves 2,009,400 short tons, and grade, 5·55 dwt. Development footage for the year was 14,289 ft. and diamond-drill footage was 4,873 ft.

FAR EAST

October 12.

Tin Industry.—Although it is a big earner of revenue for the Federation of Malaya the tin industry there is "threatened with decline because of the grave shortage of mining land," according to a booklet published by the Tin Industry (Research and Development) Board. This suggests that efforts to find tin-bearing lands to replace those nearing exhaustion are being thwarted by the absence of a co-ordinated land policy and, to improve the situation, it is thought that land policy should be designed to make the fullest use of the country's natural resources. Urging that the tin industry be given priority over agriculture and forestry in the claim for land, the Board says: "Once tin-bearing ground is alienated for any purpose other than mining, there is a grave risk of the tin being lost forever." Land set aside for tin mining covers only 1·27% of the Federation's total area, "yet," it is added, "the industry is continually in conflict with the two principal users of land, agriculture and forestry, which together occupy 32% of the country."

Attacking "unreasoned prejudice" against the industry, the Board said: "So ingrained is the fallacy that nothing will grow on land that has been mined, that most people who live outside mining areas actually believe it, although those who live on or near the mines know to the contrary, for it is on mined-out land that they grow their vegetables and fruit trees." Pilot schemes for afforestation and rubber planting on mined-out land have been successfully established with the addition of no more fertiliser than was required on estates, while mined-out land has also been very successfully converted into parks, public gardens, and recreation spaces.

Work is going ahead, it is believed, on the preparation of a new international tin agreement to succeed the present scheme. Drafts are in preparation for discussion at a conference next year, which the United Nations Organization is to sponsor in May, 1960, in New York, where the pact will be finally thrashed out.

Chinese miners in Malaya want the international agreement—which is due to expire in June, 1961, to continue, according to the All-Malaya Chinese Mining Association which has asked the Malayan Government to arrange for the barter of Malayan tin with the United States. However, the Association decided to drop the proposal when it became known that there would be an increase in the permissible export of Malayan tin.

Iron Ore.—Following the aerial survey of about 16,000 square miles of the Federation of Malaya for minerals iron-ore fields comparable with those at Bukit Besi, Trengganu, which produce Malaya's largest quantity of iron ore, have been indicated. Investigation of the area in Bukit Kepong is recommended. Further investigation has also been recommended for the areas north-west of Ayer Hitam and the Ma'okil forest reserve in a search for iron and manganese concentrations.

The Federation of Malaya's output of iron ore during the first half of 1959 was 1,600,000 tons—a total which was 30% higher than the output for the corresponding period of 1958. Japan, Malaya's biggest customer, purchased 1,300,000 tons in the first five months of the year. In 1958 the Federation produced 2,700,000 tons of iron ore.

Cement.—Cement Aids, Ltd., of Kuala Lumpur, is to set up a new plant next year at nearby Petaling Jaya, to meet increasing demand for cement additive manufactures. The company is a joint venture with the parent organization in Perth, Australia, using Malayan capital.

A total of 75,600 tons of cement was produced in the Federation of Malaya in the first half of 1959, an increase of 20,700 tons over the corresponding period of 1958. With a recent expansion programme carried out by Malayan Cement, Ltd., at Rawang, it is expected that output will go up still further. The estimated annual consumption of cement in the Federation is some 250,000 tons and the company aims to capture the entire market.

Steel Mills.—Two steel mills are to be built in West and East Java under a scheme of Russian credit for Indonesia, it is reported. They will be able to produce 50,000 tons of steel each per year.

Pakistan.—The Pakistan Geological Survey Department has stepped up mineral prospecting, a sum of Rs.1,400,000 having been provided for this purpose in the current year's Budget. To reduce the demand for imported coal the Department has studied the coal resources of the country and succeeded in locating workable deposits in the Salt Range and its extension across the Indus in West Pakistan. In East Pakistan deposits of lignite have been located in several districts and the survey carried out has put the reserve at more than 40,000 tons.

The Pakistan Government, determined to gear up mineral exploitation on scientific lines, has set aside Rs.2,600,000 worth of foreign exchange for mine owners to import modern equipment and machinery.

Lead and zinc deposits have been discovered at Ushu in the Oorgarh Valley of the upper Swat State. The town of Ushu lies about 90 miles north of Saidu Sharif, the capital of Swat. Experiments at the laboratories of the Geological Survey have revealed that the grade of ore is mineable for lead and zinc, although the deposits are believed to be too modest to be exploited on a commercial scale.

SOUTHERN AFRICA

October 28.

Gold Sales.—Following the arrangements announced earlier this year for the sale of gold to non-sterling residents by the S.A. Reserve Bank and through the Transvaal and Orange Free State Chamber of Mines, it was announced that Union Acceptances, Ltd. (an associate company in the Anglo American group) in conjunction with Samuel Montagu and Co., Ltd., of the United Kingdom, the Bank of Nova Scotia, Canada, and the Deutsche Bank A.G. of West Germany, would sell in their respective areas inter-changeable certificates, convertible into gold. In turn, a new company has been now formed—Bullion Merchants of South Africa, Ltd.—under the joint auspices of Union Acceptances, Samuel Montagu, and Mocatta and Goldsmid, Ltd., for dealing in gold bullion or the gold certificates already mentioned. In terms of the general arrangements covering the South African sales of gold the metal may be freely exported or held within the Union free of charge for an indefinite period. They also presuppose a mounting demand for gold by private buyers, which if on a considerable scale could eventually result in tight supply condi-

tions on the open market and an upward pressure on the open-market gold price.

Trade.—With imports at £326,796,000 and exports at £274,864,000 the adverse trade balance over the first eight months of 1959 improved to £41,932,000 With the 1958 figures in brackets individual 1959 exports were: Mining machinery, £2,993,440 (£3,283,337); chromite, £1,805,445 (£2,056,178); lead concentrates, (re-exports) £4,459,733, (£4,613,386); manganese ore, £2,308,970, (£3,916,636); fire-refined and blister copper £5,685,419 (£4,209,861); asbestos, £6,506,209 (£6,757,552); coal (mainly anthracite), £802,737 (£1,098,906); diamonds, £27,342,834 (£20,738,162); radioactive minerals, £32,197,417 (£34,784,308). Excluded from the foregoing were gold bullion sales of £163,470,000 (£156,065,000), the increase in 1959 being largely attributed to private gold sales.

Transvaal.—Details of the two new mines west of Winkelhaak have now been made available. Extending westwards from the western boundary of Winkelhaak is the lease area of 4,222 claims of Bracken Mines, Ltd., about 65 miles east-south-east of Johannesburg. The lease formula is 15 *minus* $\frac{90}{X}$, where X is the ratio of profits to gold revenue or recovery expressed as a percentage. In descending order of depth the succession of formations is a cover of 500–800 ft. of Karroo sedimentary beds, followed by Ventersdorp Lava, the Upper Witwatersrand Series, in which the economic horizon of the area occurs—namely, the Kimberley Reef—and the Lower Witwatersrand Series. The sub-outcrop of the reef more or less conforms with the southern boundary and dips northwards at about 30°. An intensive drilling programme was conducted in the lease area, severe faulting, water-bearing fissures, and possibly gas being indicated. Typical mineralization of the Kimberley Reef horizon, with a wide range of fluctuations of values, was disclosed by the drilling. An average grade probably upwards of about 450 in.-dwt. with payability in the range of about 50 to 60% is suggested. The high-grade zone appears to be in the central section, where the first shaft system will be sunk to a depth of about 2,700 ft. with the reef expected to be intersected in the region of 2,300–2,400 ft. The first shaft system will consist of a 17 ft. lined-diameter main hoisting shaft, downcast for ventilation, and a 14-ft. lined-diameter shaft, initially upcast for ventilation, and later converted to a downcast unit, when a series of winzes will be sunk along the sub-outcrop. Both shafts will be used for hoisting, the smaller only for rock. The hoisting capacity will support a milling rate of 90,000–110,000 tons a month. Initial milling is expected to be effected in the 1963–64 period at 65,000 tons a month, subsequently to be raised to the 90,000–110,000 range. The borehole depth of the reef ranged from 749 to 3,766 ft. Estimated capital expenditure to bring the mine to production at 65,000 tons a month is £8,500,000.

Immediately west of Bracken Mines is the lease area of 4,225 claims of Leslie Gold Mines, Ltd., which is also covered by the lease formula of 15 *minus* $\frac{90}{X}$. The geological formations are the same as that of its eastern neighbour, with additionally a capping of dolomite in the northern section. The drilling indicated characteristics similar to that of Bracken, with the Kimberley Reef dipping northwards from the sub-outcrop zone at about 25–30°. The indicated borehole grade is about 350 in.-dwt., which may well be exceeded in practice, with payability from about 45 to 65%. The borehole depth of the reef ranged from 749 to 3,766 ft. Initially providing for a milling capacity of 65,000 to 90,000–110,000 tons a month, a twin-shaft system is to be sunk in the central-south section to a depth of about 3,100 ft., in which the reef should be intersected at about 1,500 ft. The main shaft will be downcast, 23 ft. lined-diameter, and the ventilation component 14 ft. lined-diameter initially upcast for ventilation. Subsequently upcast winzes will be sunk along the sub-outcrop zone and the ventilation shaft equipped and used for hoisting, as a downcast unit probably. The initial milling rate of about 65,000 tons a month should be reached in the 1963–64 period and this will be subsequently raised to the 90,000–110,000 tons a month range. Eventually, with an ultimate milling rate of 150,000–180,000 tons a month projected, a second large-capacity shaft system will be sunk in the western section. Estimated capital expenditure to bring the mine to the 90,000 tons a month stage is £10,190,000.

Exploratory drilling and development conducted by South African Land and Exploration Co., Ltd., in the Withok area immediately south of its existing lease area have yielded disclosures that an area of about 990 claims immediately south of the lease area down to the Vogels tear fault forms a natural extension of the formations in the lease area. The fault lies about 1,200 ft. south of the present lease area and indications are that payable reef extends south of it for some undefined distance. The company accordingly applied for a lease over 4,495 claims south of the present area, which lease has been granted, and will sink a shaft system, a vertical unit to 4,260 ft. and a sub-vertical unit to about 7,350 ft. Pumping capacity will be increased. The costs of the programme have been estimated at about £3,109,000 and will be covered partly from profits and partly by a note issue, carrying conversion rights into shares. (Dividends in the immediate future will be very materially reduced.)

Durban Roodepoort Deep, at present operating two gold plants—one of 42,000 and the other of 162,000 tons a month capacity—has considered that it will be more economic and efficient to centralize these operations. Accordingly the former will be expanded to a capacity of 204,000 tons a month at a cost of £530,000 spread over two years, to be met from the company's resources. The other plant will be dismantled and sold.

With the further extension of development operations in the northern section of the Withok area adjoining its present lease area reef values have tended to decline, though they have remained above those obtained in the lease area itself. Withok's sampled values over the first nine months of 1959 averaged 228 against 279 in.-dwt. in 1958; compared respectively with 183 and 221 in.-dwt. in the lease area. It had been expected that arrangements for the exploitation of the Withok section would have been announced by about mid-1959 together with financing details. These would show whether the company would sink another shaft for the mining of Withok ore. It had been intended that initial operations would be confined to the northern zone of Withok. Possibly the company considers it to be more prudent to defer for the time being any final decision of plans for the Withok section and is probably awaiting further results from

current exploratory development. These are unofficially expected to throw more light on the orientation of the payshoot in the Withok section, especially of that shoot in the northern zone where development so far has been concentrated and possibly also of another payshoot further to the south about which information at present is speculatively meagre.

The current phase of operations at Vaal Reefs Exploration and Mining embraces the extension of development and stoping from No. 1 Shaft in the west-central section, especially eastwards, the advance of exploratory development into the extreme south-western and south-central zones, and south-eastwards towards No. 2 Shaft, which is about 9,000 ft. from No. 1 Shaft. Another point of interest in development is that northwards towards the southern Zandpan boundary, which lies about 7,500 ft. from the most northerly of Vaal Reefs workings. The southern boundary of Vaal Reefs mine is the Vaal River, which is also the northern limit of mineral rights held by the Western Holdings company, where the Vaal Reef horizon has been disclosed by drilling to lie at depths from 4,377 to 6,593 feet with values ranging from one to 328 in.-dwt., and where additional exploratory drilling is being conducted as well as further east in holdings of Freddies Development and Johannesburg Consolidated Investment companies. The trend of Vaal Reef values in the southern zones of the Vaal Reefs mine is therefore important and so far it has been encouraging.

Two mining policies are being followed now by Blyvooruitzicht Gold Mining. In the high-grade central and eastern sections, where operations are deepening, extensive off-reef development in the footwall is being accompanied by the formation of longwall stoping faces, which development is not simultaneously reflected in the ore reserves. In the lower grade and lower payable western section, where mining is scattered, exploratory development is on-reef in order to achieve the maximum exposure of reef preparatory to selective mining. Shaft-sinking policy now seems to have been decided in favour of continuing the deeper line of subincline shafts to the southern boundary and eventually transferring at least part of the ore to the new No. 4 Shaft. which is to be sunk in country rock just beyond and north of the sub-outcrop to the north. This shaft will have a lined diameter of 26 instead of 24 ft. and will be equipped with two large automatic hoists. A lengthy twin-haulage cross-cut has been advanced into the extreme south-eastern section on the 6 Level and details are awaited as to the merging of this into the future shaft and hoisting policy. Pumping capacity has been increased to 24,260,000 gallons a day by 5,760,000. Grade beneficiation and effective plant capacity have been enhanced by increasing the sorting rate to 16·9% from 13·95%.

City Deep, Ltd., and Crown Mines, Ltd., have applied for recognition as deep-level mines conducting operations more than 7,500 ft. below surface, in order to qualify for the special capital amortisation tax allowance. This would entitle them to add 5% interest to the unredeemed balance of capital expenditure each year for the purpose of calculating the amount allowed as a deduction from profits in determining the taxable income.

Features of recent operations of Doornfontein Gold Mining were the exploratory development westwards by means of two foot-wall drives and the virtual completion of operations preliminary to the sinking proper of the deep-level sub-vertical shaft in the south-east section. The object of the former—namely, delineating the position of the sub-outcrop of the Carbon Leader Reef, where it sweeps southwards, and testing its values westwards—has shown that the sub-outcrop lies somewhat further west than previously estimated and that to the west the ground is faulted with major down-throws, accompanied by dykes and water-bearing fissures. The shallower drive has accordingly been discontinued. Values have not been reported in detail from either drilling or limited footages advanced on reef to date in the westward operations.

Dominion Reefs (Klerksdorp), which does not disclose its quantitative gold output, since it is essentially a producer of uranium oxide, has found on investigation that additional gold can be economically recovered. For this purpose the mine is installing a flotation plant for the production of a pyritic concentrate from the milled mine ore prior to the treatment of the pulp in the uranium plant. This concentrate will be cyanided. The new plant will be commissioned early next year. Additional profits of about £2,500 per month should be earned. Previously the pulp from the mill was run over corduroy tables prior to transfer to the uranium section. The procedure of effecting gold extraction from the residue from the uranium plant would not be economic because of the high proportion of accumulated residues in the overall feed to the uranium plant. This practice at the nearby Hartebeestfontein mine has shown that extraction of the uranium prior to gold is more efficient.

Hartebeestfontein Gold Mining, at present sinking the Nos. 2 and 3 shaft systems, is now advancing work preparatory to the sinking of No. 4 in the south-eastern section. Sited in the deep-level section of the mine No. 4 will be sunk to a depth of 7,500 ft. below surface. The No. 4 shaft, a 24-ft. lined-diameter hoisting unit, will be equipped after hoisting and will be a little more than 1,000 ft. north of the southern boundary. The position, therefore, would facilitate exploratory development into the extreme eastern section of the Zandpan lease area southwards into ground not included to date in any lease and lying between the mine and the Vaal Reefs property and possibly even into the extreme north-eastern section of Vaal Reefs itself. The shaft will be connected up with the No. 2 Shaft workings, the latter shaft being about 8,000 ft. to the north-east.

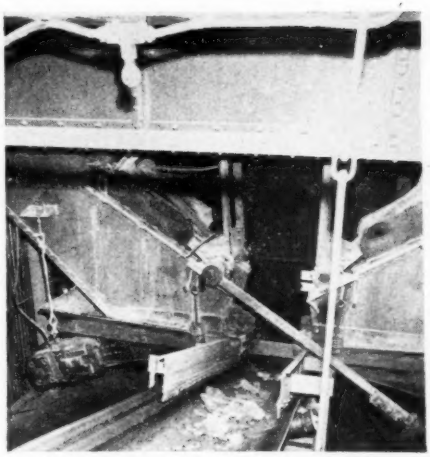
The No. 5 sub-vertical shaft of West Driefontein Gold Mining, which has penetrated through the Vetersdorp Contact and Carbon Leader Reef horizons, should be completed to its final depth, about 8,000 ft. below surface, in the immediate future, probably by the end of the first 1960 quarter. From the No. 5 vertical component drives on two levels, 16 and 18, are being advanced westwards possibly to the projected site of another sub-vertical shaft, which may be sunk in the extreme south-western section. Drilling results in the east-central section have yielded results reflecting a better outlook for the Carbon Leader there. Earlier drilling had indicated that a considerable claim zone in the north-eastern section would either be uneconomic or devoid of Carbon Leader. The recent drilling shows that the tonnage to be expected from the Carbon Leader horizon in the eastern section will therefore exceed early expectation. There is no change, however, in the disclosures that eastwards

values in the Carbon Leader fall off. The extent of the fall-off is possibly given by the recent boreholes mentioned, in which Carbon Leader values of about 270–280 and 440–460 in.-dwt. were obtained, compared with payable development results of 685 in.-dwt. in the third quarter, mainly from the north-western section. Development results from what is expected to be a very high-grade zone, the south-western section, will be of interest.

Van Dyk Consolidated has not yet reported or had payable disclosures from exploratory development on the Kimberley Reef, on which development is continuing. Van Dyk is eastwards of the East Rand Proprietary Mines property.

Orange Free State.—Harmony Gold Mining has virtually completed extensions to a capacity of 200,000–240,000 tons a month in its gold plant. In the third quarter about 142,000 tons a month were milled. Initial acid output in the nearly completed plant is expected before the year-end. Ventilation and pumping capacity have been increased, providing for the extension of operations westwards from the No. 2 Shaft, which are now in its early stage. A twin main haulage on 25 Level has been driven westwards more than 2,000 ft. into what is expected to be high-grade ground, as indicated by drilling results. Most of the stoping to date has been concentrated in the relatively lower-grade zone to the south-east. Henceforth, as the milling rate is increased, stoping in the No. 2 Shaft area will be extended. The ore-reserve grade there was last reported as 11·3 dwt., against 8·2 dwt. elsewhere. An adverse characteristic in the No. 2 Shaft area is the weak hanging-wall, associated with the khaki shale. This has meant a stoping width nearly 6 in. more than the mine average. Efforts to decrease this width are proceeding. Mining proceeds on a relatively widely spaced pattern of longwall stoping. In the recent past relatively greater effort has been devoted to off-reef development (not yet reflected in the reserve tonnage) preparatory to expansion of the stoping rate for the projected higher milling rate. Pumping capacity, which has been raised to 13,000,000 gallons a day, is to be increased further.

Preparatory to sinking the No. 3 shaft system in its south-western section President Steyn Gold Mining drilled two boreholes at the site for cementation in advance of sinking. Each of the boreholes is at the site of the main hoisting and the ventilation components, renewals, of the projected twin-shaft system. One intersected the Basal Reef at 4,624 ft., with values of 614 in.-dwt. over 23·7 in., and the other the same reef at 4,597 ft. with values of 347 in.-dwt. over 30·7 in. The new shaft system is being sited about 7,500 ft. south-west of No. 2 shaft, somewhat north of a previous borehole in which the Basal Reef was intersected at 5,224 ft. with values of 184 in.-dwt. The sinking of the new shaft system is part of an expansion programme which will raise the milling rate to the 140,000–150,000 tons-a-month mark and is expected to be completed some time in 1962. The main hoisting component will be 26 ft. and the ventilation component 20-ft. lined-diameters. The values disclosed in the two boreholes mentioned tend to confirm expectations that relatively high values disclosed to the west in the President Brand mine persist eastwards into the Steyn area, at any rate to a degree. The two values mentioned above raise the indicated average borehole grade for the Steyn lease area somewhat to the range of 270–350 in.-dwt. over



Aerofall Mill Feed, East Daggafontein.

45·67 in., with indicated payability of about 45 to 55%. At September 30, 1959, the ore reserves averaged 379 in.-dwt. over 45·67 in., while in the third quarter the yield improved to 7·84 dwt. Sinking the No. 3 shaft system is now in its early stages, the construction of headgears and the installation of hoists, etc., having been completed in the third quarter. In addition to the Basal Reef the mine is advancing smaller footages of development on the lower-grade Leader Reef horizon. Supplementary tonnages therefrom will have a diluent effect probably on the mill grade, which effect, however, is being offset by more intensive sorting and would be offset further by the projected expansion of milling. Over the last two quarters the monthly rate has been raised to about 105,000 from the previous average of about 93,000 tons. The final depth of the No. 3 System will be about 6,200 ft. Unless the heavy post-production capital expenditure has materially deferred the onset the company should become liable for tax and lease payments in the near future.

Drilled by Western Holdings to obtain geological information, a borehole in the north-western section of the mine, about 6,000 ft. west-north-west of No. 1 Shaft and about 5,000 ft. south-east from Geduld borehole No. 1, intersected the Basal Reef at 3,806 ft. below surface with values of 184·3 dwt. over 13·1 in. or 2,414 in.-dwt. in a complete core recovery. About 2,000 ft. west of current workings, and located in a zone about which little was previously known, the borehole has supplied confirmation of the persistence of high-grade values over an extensive area, southwards from the No. 1 Shaft area of F. S. Geduld down to the No. 3 Shaft area of Western Holdings, which is about 7,000 ft. south of the above borehole, even after allowing for intermittent fluctuations.

Free State Saaiplaas is equipping a second shaft, following the completion of sinking and the equipping of one. In the latter pumping capacity of 1,500,000 gallons a day has been installed which is being increased to 5,500,000. Reef development has been initiated from this shaft. Erection of the gold plant is in its early stages.

Trade Notes

Brief descriptions of developments of interest to the mining engineer

New Research Laboratories

New research laboratories recently completed for the **Cambridge Instrument Co., Ltd.,** of 13, Grosvenor Place, London, S.W. 1, at Cambridge were formally opened last month, by Lord Adrian, Vice-Chancellor of the University. The new building, comprising a three-storey entrance block and four-storey laboratory block, is situated adjacent to the company's existing factory and has been finished in one year. They form a striking example of co-operation between scientist, architect, and builder in providing a pleasing edifice admirably adapted to the work for which it is designed.

In the course of a visit we were able to see something of the work in progress and to learn of recent instrument developments of interest in many different scientific fields. Thus the scanning electron-probe X-ray microanalyser provides a valuable method of qualitative and quantitative metallurgical analysis. Its technique is that of irradiating a minute area of the surface of a metallic sample with a fine-focus beam of electrons and analysing the resulting emission of X-rays excited in the sample. An important feature is the incorporation of a deflection system in the electron microscope so that the electron beam can scan the surface of the sample. The instrument is not, therefore, restricted to point by point micro-analyses. It can also produce X-ray images showing, in turn, the distribution of selected elements over the area scanned. The X-ray image is displayed on one of two cathode-ray tubes. The other tube simultaneously displays a reflection electron image of the same area so that a direct visual comparison between the surface topography of the specimen and the distribution of a selected element can be made easily.

A new device for determining carbon monoxide is under development. It embodies an extension of well-established methods, in which a catalyst is used to promote the oxidation of carbon monoxide in excess air, the resulting temperature rise during the exothermic reaction being used to estimate the amount of carbon monoxide originally present. A novel test-cell enables high sensitivity and rapid response to be obtained with low rates of gas flow. The apparatus dimensions are much reduced compared with those of some of the earlier equipment produced by the company.

In another field is the accurate determination of dissolved oxygen in concentrations of less than 0·01 parts per million. This instrument uses an indifferent gas, hydrogen, to transfer the dissolved oxygen physically from the feed water to an electro-chemical measuring cell that is specific for oxygen. The gas-transfer system separates the oxygen from non-volatile impurities in the feed water which may cause serious errors of measurement. Volatile impurities—such as, sulphite, hydrazine, and cyclohexylamine—do not affect the measurement.

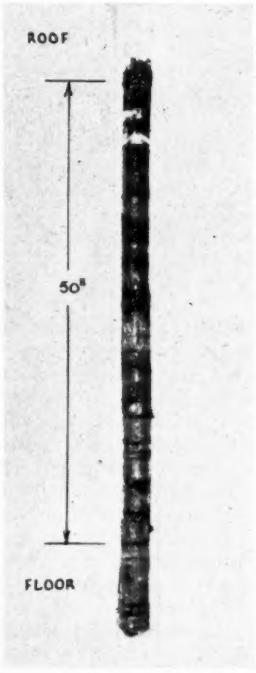
Recovery of Friable Drill Cores

At a demonstration staged early in October on an N.C.B. site near Ashby-de-la-Zouch the **Turriff Construction Corporation, Ltd.,** of Budbrooke Road, Warwick, were able to demonstrate in convincing fashion the technique they have developed for the recovery of drill cores in unconsolidated or friable strata. Using air as the flushing medium the cores are taken into a plastic sheath within the core barrel and removed in one piece. The corporation states that originally plastic tubes were made up and inserted into the barrels, but now the plastic is merely rolled into a tube, placed in the inner barrel, and left to form its own diameter, being wrapped at 6-in. intervals with tape during extraction. Using this method cores in their original order and condition can be preserved in the core box and kept indefinitely by making good the sheath with adhesive tape after it has been slit open for examination.

Turriff Construction, which, for the purposes of the demonstration was using a Reich

Core Removed in Plastic Tube.

Model 600 drill and a Boyles B.B.S. 20 A/F, uses three types of core barrel. For the 4-in. core either a Boyles Bros. Type 550 or the original barrels supplied with the Reich drills, manufactured by Spraque and Henwood were in use, while barrels used with the B.B.S. 20, which give a 3-in. core, were also by Boyles Bros. and specially designed for air flush ; they are known as their Type 412.



Specimen Core in Friable Coal.

The Corporation points out that the patented process, developed originally from using double-tube core barrels on the 3-in. and 4-in. rigs in coal formations has obvious advantages, some of them already mentioned. The sheathing material, a polyester film marketed under the trade name "Mylar" is expendable, as well as being tough and untearable, yet easy to cut and re-seal. The process itself, of course, will obviously have a wide application when a complete record is required in friable ground.

Electric Motor for Vibrating Drives

A new electric motor designed for vibrating mechanism drives is being produced jointly by the **English Electric Co., Ltd.,** of Stafford, and the **Grantham Electrical Engineering Co., Ltd.,** of Grantham. The completely self-contained unit is described as providing an inexpensive and reliable drive by eliminating all the mechanical parts associated with an eccentric-shaft arrangement. Vibration is generated by out-of-balance weights at either end of the motor which can easily be adjusted by single bolts to give the required output. The motor is totally enclosed, dust-proof, and weather-proof. The frame is of nodular cast iron, with integral feet, and the shaft is of high-tensile steel to withstand the high centrifugal forces to which it is subjected.

Because of its vibrating motion the motor must be mounted on a resilient base. Operating at 1,500 r.p.m. synchronous speed it has a power output of up to 7,500 lb.

Chaseside Loadmaster 1000.

centrifugal force, or 10,000 lb. at 3,000 r.p.m., which is ample for all applications at present envisaged. The motor is operated from a three-phase 50-cycle supply at 110–650 volts. Greater outputs and other supply frequencies can be provided for. The present range comprises eight units from ½ h.p. to 1½ h.p.

Earth-Moving Equipment

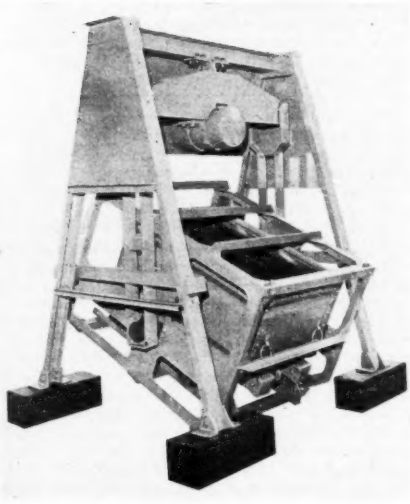
Earlier this year the **Chaseside Engineering Co., Ltd.,** was merged with **British Northrop, Ltd.,** of Blackburn, in which organization the Chaseside company forms the nucleus of a "Construction Equipment Division." Last month British Northrop afforded an opportunity of visiting the production facilities now available to Chaseside in Lancashire for the manufacture of the present range of loading shovels and particularly of the new series of four-wheel drive "Loadmasters," one of which, the "1000," is illustrated.

These new Chaseside four-wheel drive models can be considered as an extension to the two-wheel drive loading shovels. The Loadmaster 3000, the largest new model in the range, is eminently suitable for those tasks in construction work calling for a 3-cu. yd. scoop with a payload of 10,000 lb. The Loadmaster 1000 is virtually a combination of the proved 700 and 800 TC types; the outstanding features of both of these models *plus* four-wheel drive are combined in the Loadmaster 1000 with a payload of 7,000 lb. This new model employs a Chaseside transmission with torque converter and hydraulically-operated multi-disc clutches for forward and reverse.

The British Northrop Construction Equipment Division is to produce the complete range of Loadmasters, as well as Chaseside "Hi-Speed" dumpers of payload 13,500 lb., Chaseside power packs—completely self-contained sources of power for ancillary equipment such as irrigation plants, saw mills, etc.—and a large range of ancillary equipment, including special scoops for quarries and demolition contractors, bulldozer blades, crane hooks, etc.

Mine Tub Shake-Out

A newly designed mine tub shake-out, which has been developed and manufactured by Sinex Engineering Co., Ltd., is now being marketed by **Holman Bros., Ltd.,** of Camborne. As is known the ineffective and incomplete emptying of mine cars results in a gradual build-up of residual material and this accumulation of damp dust may set in a very short time into a concrete-like mass. The new Sinex device comprises a robust support frame in which is pivoted a tippler cage. The tippler cage, which accommodates cars of up to 1 ton capacity, is suspended by two hanging trunnions from a beam structure which carries a 3,000-r.p.m. rotary electric high-amplitude vibrator. The cars are



inverted after being placed in the tippler cage and vibrated for some 50 seconds during which time all deposits completely disintegrate and fall away.

The rolled-steel channel "A" frames which support the vibrator unit and tippler cage are fitted with rubber shock and vibration absorbers and bolt holes are provided for permanent installation and for grouting into concrete. The vibrator is suspended below the beam with anti-vibration mountings. The beam is constructed in heavy sheet steel to which is attached two hanging trunnions, one at each side of the beam. To the lower end of each trunnion is fitted a bearing journal which has a large surface area. The bearings are the pivot points for the tippler cage, which is fabricated in steel plate and angle iron to form a rigid enclosure for the mine car. The vibrator operates with currents at 1½ amp. per phase at 400/440 volts. The centrifugal force varies between 4,000 lb. and 7,500 lb. depending on the vibrator power requirement. The shake-out can also be supplied to handle tubs of up to 5 tons capacity.

Personal

A. C. J. ANDERSON has returned to Nigeria.

Lord BAILLIEU, president of the Dunlop Rubber Company, has been elected the first president of the British Institute of Management.

B. BARTLETT is home from Ghana.

JOHN P. BELL has left for South Africa.

H. F. BURTON, of Mackay and Schnellmann, is temporarily leaving Iran and returning to England, after which he will be proceeding to Burma.

E. F. DARK has left on a short visit to Surinam.

E. K. DICKINS is home from India.

HAROLD C. DRAYTON and J. D. MCCALL have been appointed directors of the Consolidated Gold Fields of South Africa, Ltd., and of New Consolidated Gold Fields, Ltd.

A. R. J. GASKIN is now a lecturer in the Department of Geology, Leeds University.

JOHN F. GATES, regional director for Central and Southern Africa of Cyanamid International, has been appointed regional director for Africa.

JOHN HARRISON has been appointed managing director of Atlas Copco (Great Britain), Ltd., in place of J. C. GREIG, who has resigned.

G. HARVEY is returning from Ghana.

L. A. HILL is now in Uganda.

G. S. INNS is home from Canada.

D. J. O. MANN, of John Lysaght's Scunthorpe Works, Ltd., has been awarded a Mond Nickel Fellowship to study the practical applications of recent metallurgical research and techniques to the production of basic semi-finished steel.

J. W. MEREDITH, managing director of Huntington, Heberlein, and Co., Ltd. (a subsidiary of Simon-Carves, Ltd.) has been appointed a director of Simon-Carves, Ltd.

G. C. NORMAN is home from Portugal.

B. S. PECK is home from Ghana.

N. J. B. POCOCK, of Capper Pass and Son, Ltd., has been awarded a Mond Nickel Fellowship to study developments in extractive metallurgy in the United Kingdom, Europe, the U.S.A., and Canada and their dependence on the size and location of the organizations concerned.

D. W. PRINGLE is now in Tanganyika.

C. HARVEY RICHARDS is returning from Pakistan.

G. A. SCHNELLMANN has left on a professional visit to Portugal.

S. L. SEGAL is now chairman of Dominion Reefs (Klerksdorp), Ltd., in place of M. E. RICH, who is still a director.

D. J. SIMMONS, of Mackay and Schnellmann, has returned from Western Asia and will shortly be going to South America.

CLARENCE THOM, director of the Denver Equipment Company's ore-testing division for nearly 25 years, has become consulting metallurgist for the company and its clients.

T. A. WELLSTED has been appointed a director of the Central Provinces Manganese Ore Co., Ltd.

W. G. YUILL, of Mackay and Schnellmann, Ltd., has left for a short visit to Spain.

THE INSTITUTION OF MINING AND METALLURGY

Elections and Transfers

Member.—Samuel Harrison CLARKE, M.Sc. (*Knebworth*).

Associate Member to Member.—Laurence Alington

CROZIER (*London*); Dowl FOORD, B.Sc., A.O.S.M. (*Jos*); Alan KELLY, A.C.S.M. (*Mufulira*); George St. John Oxley OXLAND, B.Sc. (*Rooiberg*).

Associate Member.—Julian CHUCHLA, A.C.S.M. (*Potrerillos, Chile*); John Raymond JAY, B.Sc. (*London*); Thomas Peter JONES, B.Sc. (*Kitwe*); Ladislav KROPACEK (*Tororo, Uganda*); Denis Walter MCMAHON, B.E. (*Mufulira*); Norman MUSGRAVE, B.Sc. (*Bulawayo*); Peter Frank NORRISH, A.R.S.M., B.Sc. (*Sheffield*); Stephen Nwachukwu OFOMAH, A.C.S.M. (*Swansea*); Roy Constant Martin VAN DER SPUY, B.Sc. (*Rooiberg*).

Affiliate or Student to Associate Member.—Denys Stuart LAWRIE, B.Sc., A.R.S.M. (*Sungei Lembing, Malaya*); Peter David Ralph MALTBY, B.Sc., A.R.S.M. (*Spragge, Ontario*); Peter John NUNN (*Sutton Coldfield*); Noel Eric POSSELT, A.C.S.M. (*Bancroft*).

Affiliates.—Victor Frederick Immanuel ANDREWS (*Hulti, S. India*); Lieh-Leng CHENG, Ph.D. (*Pittsburgh*); Ebenezer Kefi EDJAH (*Camborne*); Alan Robert Dundas ORR (*Glasgow*); Ulric Bernard SCHIJF, B.Sc. (*Luanshya*).

Student.—Donald Charles BAILEY, A.C.S.M. (*Camborne*); Ah Moy CHAN, A.C.S.M. (*Camborne*); Jeffrey Boardman CLAMP (*Konongo*).

Metal Markets

During October [1]

Copper.—For the greater part of October prices of copper on the London Metal Exchange have shown a surprising, indeed exemplary, stability in the face of a most provocative world market situation.[2] There has, however, been an exception to the rule. At the point of maximum squeeze on spot supplies prices were unable to avoid reacting strongly upwards and a peak of £265 for cash, allied with a backwardation of £20 per ton, was seen. This was reasonable enough but the subsequent reaction was not quite so reasonable, being largely the product of a technical situation on the market, even though it must be admitted that the existence of such a situation was a natural corollary to the market background.

It is perhaps as well to chronicle the main features of that background during the past month as this has changed fairly rapidly. In the first place the strikes at U.S. copper mines have continued unabated, notwithstanding a partial easing of the steel strike deadlock. Indeed another strike against a minor producer—White Pine Mines—has been added to the list. This has naturally led to a good deal of additional demand for copper—both in raw and semi-fabricated forms—coming to Europe. Although this has on the whole not been matched by additional inquiry from European consumers it has naturally had a stiffening effect as well as reducing the level of stocks in London Metal Exchange warehouses week by week. The unconcern of European consumers has undoubtedly been one of the saving graces of the market over recent months although there was certainly some additional buying by consumers receiving *force majeure* notices in respect of copper due to arrive in the November shipments from Chile. The strike at El Teniente has just, at the time of writing, been settled, but this will not eliminate the gap in arrivals from that source. At the same time sentiment has naturally taken an easier turn, especially in Europe, as a result of the news.

U.S. demand in Europe has, of course, only been possible as a result of swift action to nullify the dock workers' strike in the U.S.A., to which reference was made last month. Within a week the President had secured a back-to-work injunction under the Taft Hartley laws.

The basic copper situation is, therefore, now a most unhappy one. U.S. consumers are definitely short of metal (obviously more in some types than others) and the producers there are not able to supply any additional metal until the strike ends and some of the copper stored in their plants can be released. In any case the strike has effectively rectified the top-heavy world statistical position and, in fact, put the boot on the other foot. The problem facing users, of course, is how long will it be before the strike is settled and the normal situation of excess production is restored? It can only be said that the longer the strike lasts the longer such a development will be delayed.

In the holiday month of August U.K. copper consumption was 40,621 tons (30,886 tons refined). Production of primary refined was 5,902 tons and secondary refined 5,651 tons. Stock movements were from 69,049 tons of refined to 74,347 tons and from 12,937 tons of blister to 15,136 tons.

Tin.—Tin has been no more interesting from a market point of view in October than in any of the last few months. Despite the U.S. steel strike and its obviously adverse effects on consumption in the U.S.A., through the inaction of the tinplate industry, it has not been difficult for prices to remain in the neighbourhood of £794 per ton throughout the month.[1] It is difficult to say whether any great deal of Buffer Stock tin is being placed on the market but the general impression is that when an opportunity for unobtrusive disposals arises it is taken.

It is, of course, none too soon to be taking a long-term look at the possibilities that arise in connexion with the necessity to terminate or renew the present Agreement in 1961. Now that day-to-day movements in tin are so stable it is necessary to look at the market in this way. On the assumption that most things are already being ordered on the basis of continued operation of the Agreement it is unlikely that any steps will be taken to run the Buffer Stock down to less than a minimum useful operating level at any date before this is absolutely necessary. In due course the quotas for the first part of next year will come up for consideration, which will pose some nice problems.

U.K. August use was 1,224 tons and production 1,908 tons. Stocks fell to 10,752 tons.

Lead.—There was a mild improvement in lead sentiment towards the end of the month, but for most of October most market observers preferred to forget about lead, the position of which is particularly unsatisfactory, in the market sense, although consumers are no doubt highly delighted.[1]

U.K. August consumption was 23,358 tons and production of English refined 6,624 tons. Stocks were little changed at 66,048 tons.

Zinc.—Although the peak prices[1] seen in zinc

[1] Recent prices, pp. 224, 272.
[2] See Table, p. 272.

[1] See Table, p. 272.

in October—not so far from £100 per ton—have not been maintained there is not much wrong with the short-term position of this metal. Consumption is quite strong in Europe and will presumably improve in the U.S.A. with an end to the steel strike. Meanwhile the production cuts instituted under United Nations auspices have been effective; indeed as far as the spot position is concerned almost too effective. Yet nothing has been done to remove the brake on supplies and there is some suspicion of this artificial statistical strength, the more it is seen to be artificial. With restriction at the concentrates stage, however, the next two months at any rate look promising.

U.K. August consumption was 21,566 tons, production 5,860 tons and stocks rose to 40,358 tons.

Iron and Steel.—The recovery in the U.K. steel industry is maintained. Last month steel production rose to an annual rate of over 22,000,000 tons and with demand increasing there is a good chance that output will attain a new all-time record rate before the close of the year.

The call is still strongest for the lighter products—such as, sheets, tinplate, bars, and strip—but slowly the interest for plates, heavy sections, and large-diameter pipes is strengthening. Railway material remains rather depressed.

The phenomenal activity in the motor-car industry, which is now operating at a rate earlier expected to be attained in 1962, has thrown a heavy strain on reduced cold sheet steel supplies. Because of new plant teething troubles at the British strip mills and the loss of imports from the U.S.A. owing to the strike one firm has run into a marginal shortage of sheets and has had to restrict output, but with sheet output rising from the home mills no serious difficulties should be experienced. Indeed it is hoped that sheet production will rise by 25% next year.

Meanwhile the U.K. maintains its iron and steel export trade at a good level and one comfortably above last year's. Imports fluctuate a little between 45,000 tons and 55,000 tons per month and consist mainly of sheets, ferro-alloys, and pig iron.

Iron Ore.—In September U.K. iron ore imports rose to 1,318,143 tons, the highest figure since June, 1958, but arrivals for the first nine months of the year are still below those of the corresponding period of 1958 by more than 700,000 tons.

Aluminium.—Business in aluminium in the United Kingdom has picked up somewhat in recent weeks, in accordance with the general tendency for a rise in industrial activity to which the business world has been looking in the past few months. The present boom in the motor industry is a big contributory factor so far as the present upsurge in demand for aluminium is concerned—particularly as regards secondary ingots and scrap, which are needed for castings. There is, in any case, a certain tightness in scrap supplies and the ingot market is healthier than it has been for some time.

Prices of both ingot and scrap metal have been on the increase lately and by the end of October ingot prices were as much as £10 a ton up on those in force at the beginning of the month. Such a rise has not brought about any slackening of the demand, even momentarily, as some people might have feared. It is particularly good from Western Germany at the moment.

Canadian-produced ingots made to specification B.S. 1490 LM6—ingots containing some 10% to 13% silicon—were available in the United Kingdom at the end of the month at prices up to £6 a ton less than the cheapest available secondary ingots. While not regarded by the smelters as a good thing, this was not causing them any great anxiety at the time since most of them were operating at as near full capacity as their raw material supplies would allow them anyway.

Canadian primary aluminium is still available at £180 a ton, delivered.

Antimony.—October was a quiet month as far as the market in antimony was concerned and prices are still at the same levels as they have been for some little time past, English regulus fetching some £197 10s. a ton delivered. The U.S. Bureau of Mines announced last month that American domestic production of primary antimony metal in the second quarter of 1959 was up by some 24% on that for the preceding quarter and was considerably higher than the quarterly average output last year. Imports, however, were down in the same three months by about 13% although imports of oxides—particularly from Yugoslavia and the United Kingdom—actually increased.

Arsenic.—Arsenic prices remained stable throughout the month. It continues to fetch £400 a ton. The trioxide is currently priced at £40 to £45 a ton, ex stock.

Bismuth.—Last month was another quiet one so far as trading in bismuth was concerned and the present price remains at a nominal 16s. per lb. for 1-ton lots.

Cobalt.—The results of a United States investigation into the import position on cobalt metal were made known at the beginning of October. Contrary to domestic producers' hopes the investigators firmly rejected the idea of changing tariffs or quotas. The United Kingdom open-market price is still 14s. a lb., while the contract price remains at 12s. 6d. a lb.

Cadmium.—The United States price of cadmium has risen by 10 cents a lb. and the metal now sells at $1·30 per lb. delivered for 1-ton lots and $1·40 per lb. for small quantities. The United Kingdom price is still 9s. a lb. for 1-cwt. lots of U.K. and Empire metal and there seems little likelihood of any rise in the immediate future in view of the very competitive nature of the world market as a whole and, more especially, the European market.

Chromium.—Chromium metal continues to be quoted at between 6s. 11d. and 7s. 4d. a lb.

Tantalum.—Occasional European demand for tantalum ore during the course of the past month has kept the price stable at 650s. to 700s. a unit.

Platinum.—The open-market price of platinum remains in the range £26 15s. to £27 10s. an oz. and the undertone is quite firm, although there was somewhat less business done during October than in the previous month. United Kingdom and Empire refined metal continues to be quoted at £28 10s. per troy oz.

Iridium.—Iridium is currently being quoted at £24 to £26 15s. per troy oz., although this is only nominal owing to the very small amount of business which has been done in this metal in recent weeks.

Palladium.—A slight improvement in the statistical position as regards palladium enabled sellers to advance their prices towards the end of the month. Palladium is now fetching £8 per troy oz. as against £7 5s. previously.

Osmium.—Trading in osmium is now almost at a complete standstill. The current quotation is nominally £23 to £32 5s. per troy oz.

Tellurium.—The price of tellurium lump and

powder is still 18s. a lb., while that of tellurium sticks remains at 20s. a lb.

Tungsten.—The tungsten-ore market grew progressively weaker in the first half of October and prices fell to 125s. to 130s. per long ton unit by mid-month. At first there was more material arriving in Europe than was either bought or consumed. Then buying picked up and supplies grew less until consumers found themselves forced to fall back on Government stocks which sold at around 127s. 6d. a unit. Towards the end of the month the volume of business tailed off slightly, almost all that which was done being in Government ore. Most members of the trade were of the view at the end of October that there was unlikely to be any worthwhile improvement in prices until all the Government stocks were finally depleted and no one was prepared to hazard a guess as to when this might be.

Nickel.—Nickel has presented few new market features recently and the metal is still quoted at £600 a ton delivered for refined material.

Early in the month the Japanese company Shimura Kako announced that it had signed an agreement with the Anglovaal company whereby it had become a part-owner of the Trojan nickel mine at Bindura, in Southern Rhodesia. If reports are correct the mine may soon be increasing its output quite considerably for the Japanese firm is said to be planning to construct a £1,000,000 refining plant in the Bindura area.

Chrome Ore.—Rhodesian metallurgical chrome ore is still quoted at £15 15s. per ton c.i.f. Prices of Turkish material, on the other hand, are now reported to be mainly a matter of negotiation between buyer and seller to the extent that minimum prices have lost almost all significance. The only actual movements of ore that have been reported from Turkey recently, however, all seem to have been at the last established price—as a result of long-standing contract arrangements—and there were no definite reports of material changing hands at prices as low as £29 as some observers had claimed.

Molybdenite.—There is now quite a substantial demand for ferro-molybdenum so far as Europe is concerned. Notwithstanding this and the fact that Kennecott's molybdenum-producing properties in both North and South America are now strike-bound there is no danger of any shortage in the near future. Consumption in the U.S.A. has naturally fallen during the steel strike and Climax Molybdenum is understood to have accumulated strong reserves. The price of molybdenite remains at 8s. 11d. per lb. Mo contained, f.o.b. mine.

Manganese Ore.—Business in manganese ore was on the dullish side in October. Japan was pretty well out of the market, its steel and ferro-alloy producers being more or less fully covered in their requirements, but observers think there is a good chance of them expressing renewed interest this month when more foreign exchange is likely to be available to them. Nor was there much inquiry from Scandinavia, where drought conditions had a certain adverse effect on the production of ferro-alloys.

The quoted price c.i.f. U.K. for 46% to 48% ore remains at 68d. to 73d. per unit of Mn despite a small rise in the freight basis.

Tin, Copper, Lead, and Zinc Markets

Tin, minimum 99·75%; Copper, electro; Lead, minimum 99·75%; and Zinc, minimum 98%, per ton.

Date	Tin		Copper		Lead		Zinc	
	Settlement	3 Months	Spot	3 Months	Spot	3 Months	Spot	3 Months
	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.
Oct. 9	794 10	794 15	232 2½	232 7½	70 11¼	71 8¾	87 2½	85 8¾
12	794 10	794 15	230 7½	230 12½	70 11¼	71 6¼	87 7½	85 7½
13	794 10	794 5	230 17½	230 17½	70 11¼	71 8¾	88 11¼	86 2½
14	794 10	794 5	232 10	232 7½	70 1¼	71 6¼	88 17½	86 11¼
15	794 0	793 5	234 12½	234 2½	69 11¼	71 5	90 15	88 2½
16	794 0	791 15	234 5	233 12½	70 11¼	71 8¾	90 11¼	87 18¾
19	794 10	793 15	235 2½	234 10	70 8¾	71 11¼	91 15	89 5
20	794 10	794 5	240 2½	237 7½	71 2½	72 3¾	94 2½	90 17½
21	794 10	794 5	243 15	239 5	71 13¾	72 11¼	96 17½	93 2½
22	794 10	794 5	249 10	240 17½	71 12½	72 7½	96 15	92 17½
23	794 10	794 15	260 10	245 5	71 3¾	71 17½	93 5	89 17½
26	794 10	794 5	256 5	241 15	71 1¼	71 17½	94 17½	90 17½
27	794 10	795 0	264 15	245 15	71 3¾	72 2½	96 7½	91 17½
28	794 10	795 5	265 5	247 15	70 17½	71 15	97 5	92 2½
29	794 10	795 10	254 10	241 10	70 1¼	71 2½	96 5	91 7½
30	794 0	795 15	258 10	244 15	71 2½	71 17½	97 17½	92 7½
Nov. 2	794 10	796 5	252 10	242 15	71 16¼	72 6¼	95 10	91 15
3	794 0	795 15	252 10	242 10	72 1¼	72 3¾	95 12½	91 12½
4	794 0	795 15	254 15	244 5	74 3¾	73 16½	95 0	91 5
5	794 0	797 5	259 10	247 15	74 8¾	74 1¼	93 7½	89 15
6	794 10	798 5	259 10	247 17½	74 7½	73 13¾	93 5	89 12½
9	794 10	798 5	265 15	250 5	73 12½	73 1¼	96 7½	91 7½
10	799 0	802 15	266 5	250 5	73 3¾	73 3¾	95 12½	90 12½

Statistics

TRANSVAAL AND O.F.S. GOLD OUTPUTS

	Sept,		Oct.	
	Treated Tons	Yield Oz.†	Treated Tons	Yield Oz.*
Blyvooruitzicht	127,000	84,456	129,000	86,105
Brakpan	138,000	17,027	143,000	17,186
Buffelsfontein‡	144,000	54,754	145,000	55,618
City Deep	114,000	23,488	112,000	23,522
Cons. Main Reef	90,000	17,842	91,000	17,270
Crown Mines	221,000	35,185	223,000	35,942
Daggafontein	244,000	48,265	238,000	47,600
Doornfontein‡	95,000	38,565	95,000	38,575
D'rb'n Roodeport Deep	194,000	35,660	200,000	36,616
East Champ D'Or‡	12,000	369	12,000	371
East Daggafontein	104,000	17,628	104,000	17,679
East Geduld	143,000	42,186	143,000	42,195
East Rand P.M.	210,000	56,230	220,000	58,000
Eastern Transvaal Consol	19,000	6,339	18,900	6,202
Ellaton‡	30,500	6,996	30,000	9,949
Freddies Consol.	61,000	14,587	64,000	14,775
Free State Geduld	93,000	76,362	93,000	77,429
Geduld	75,000	14,367	78,000	14,955
Government G.M. Areas‡	52,000	10,706	54,000	11,046
Grootvlei Proprietary	225,000	47,026	225,000	47,025
Harmony Gold Mining	138,000	54,863	141,000	56,053
Hartebeestfontein‡	91,000	48,230	102,000	52,020
Libanon	110,000	25,734	112,000	26,413
Loraine	82,000	16,194	82,000	16,400
Luipaards Vlei‡	125,000	14,544	123,000	14,224
Marievale Consolidated	97,000	23,436	100,000	24,100
Merriespruit‡	—	—	—	—
Modderfontein East	137,000	13,281	142,000	13,708
New Kleinfontein	81,000	10,814	85,000	10,874
New Klerksdorp‡	10,800	1,258	10,000	1,170
President Brand	120,000	98,406	117,000	96,233
President Steyn	104,000	41,310	104,000	41,288
Rand Leases	191,000	28,366	195,000	28,860
Randfontein‡	208,000	14,494	200,000	13,486
Rietfontein Consolid't'd.	16,000	4,302	16,000	4,304
Robinson Deep	56,000	11,107	55,500	11,032
Rose Deep	34,000	5,652	31,000	5,042
St. Helena Gold Mines	160,000	50,403	160,000	50,809
Simmer and Jack	82,000	16,528	82,000	16,433
S. African Land and Ex.	98,000	20,433	97,000	20,225
S. Roodepoort M.R.	30,000	7,088	31,000	7,273
Spaarwater Gold	11,000	3,421	11,000	3,424
Springs	105,000	14,384	105,000	14,453
Stilfontein Gold Mining‡	159,000	71,600	160,000	72,096
Sub Nigel	66,500	15,744	66,500	15,751
Transvaal G.M. Estates	6,700	1,866	7,300	1,933
Vaal Reefs‡	100,000	45,000	100,000	45,000
Van Dyk Consolidated	73,000	14,004	74,000	13,509
Venterspost Gold	126,000	31,721	126,000	32,017
Village Main Reef	30,000	4,769	32,000	4,820
Virginia O.F.S.‡	132,000	30,360	132,000	30,195
Vlakfontein	52,000	18,617	52,000	18,612
Vogelstruisbult‡	88,000	19,932	90,000	19,611
Welkom Gold Mining	100,000	31,261	98,000	30,949
West Driefontein‡	102,000	93,391	107,000	97,987
West Rand Consol.‡	215,000	21,942	221,000	22,576
Western Holdings	137,000	85,627	136,000	86,340
Western Reefs	141,500	37,498	141,500	38,205
Winkelhaak	80,000	21,809	83,000	23,028
Witwatersrand Nigel	18,400	4,383	18,800	4,381

† 250s. 0d. * 249s. 6d. ‡ Gold and Uranium.

COST AND PROFIT IN THE UNION

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
Sept.,* 1958	16,760,400	65 10	46 9	19 1	25,633,898
Oct.	—	—	—	—	—
Nov.	—	—	—	—	—
Dec.	16,540,150	67 7	47 10	19 9	25,934,441
Jan., 1959	—	—	—	—	—
Feb.	—	—	—	—	—
Mar.	16,743,500	68 0	45 4	22 8	25,934,881
April	—	—	—	—	—
May	—	—	—	—	—
June	17,845,100	69 1	45 2	23 11	28,473,191
July	—	—	—	—	—
August	—	—	—	—	—
Sept.	—	—	—	—	30,140,529

* 3 Months.

PRODUCTION OF GOLD IN SOUTH AFRICA

	Rand and O.F.S.	Outside	Total
	Oz.	Oz.	Oz.
October, 1958	1,516,701	44,025	1,560,726
November	1,484,844	32,349	1,517,193
December	1,480,525	40,372	1,520,895
January, 1959	1,506,670	39,515	1,546,187
February	1,472,090	34,618	1,506,708
March	1,561,196	32,271	1,593,467
April	1,616,891	36,815	1,653,706
May	1,641,990	30,371	1,672,361
June	1,665,503	34,465	1,699,968
July	1,700,968	48,414	1,749,382
August	1,699,008	36,052	1,735,150
September	1,701,485	36,567	1,738,052

NATIVES EMPLOYED IN THE SOUTH AFRICAN MINES

	Gold Mines	Coal Mines	Total
January 31, 1959	350,656	—	—
February 28	396,217	33,859	430,076
March 31	379,257	32,982	412,239
April 30	383,710	33,081	416,791
May 31	385,278	33,186	418,464
June 30	383,903	33,146	417,049
July 31	381,190	33,295	414,485
August 31	377,257	32,994	410,251
September 30	371,813	32,903	404,716

MISCELLANEOUS METAL OUTPUTS

	4-Week Period To Oct. 24		
	Tons Ore	Lead Concs. tons	Zinc Concs. tons
Broken Hill South	16,080	2,586	2,882
Electrolytic Zinc	17,259	920	5,073
Lake George	12,001	801	1,620
Mount Isa Mines**	64,671	4,060†	2,242
New Broken Hill	41,860	6,174	11,651
North Broken Hill	23,866	4,747	4,897
Zinc Corp.	60,870	9,477	9,457
Rhodesia Broken Hill*	—	—	—

* 3 Mths. ** Copper 4,100 tons. † Metal.

RHODESIAN GOLD OUTPUTS

	Sept.		October	
	Tons	Oz.	Tons	Oz.
Cam and Motor	32,062	—	32,355	—
Falcon Mines	20,350	3,855	20,500	3,901
Globe and Phœnix	5,600	2,912	6,000	3,053
Motapa Gold Mining	—	—	—	—
Mazoe	2,814	—	2,915	—
Coronation Syndicate	11,939	—	11,942	—
Phœnix Prince*	—	—	—	—

* 3 Months.

WEST AFRICAN GOLD OUTPUTS

	Sept.		October	
	Tons	Oz.	Tons	Oz.
Amalgamated Banket	60,108	14,703	61,015	14,027
Ariston Gold Mines	40,160	13,420	40,000	13,339
Ashanti Goldfields	34,000	27,900	40,000	32,500
Bibiani	33,500	7,200	33,500	7,200
Bremang	—	8,016	—	5,109
Ghana Main Reef	11,448	4,135	12,084	4,015
Konongo	6,500	3,780	6,510	3,775
Lyndhurst	—	—	—	—

PRODUCTION OF GOLD AND SILVER IN RHODESIA

	1958		1959	
	Gold (oz.)	Silver (oz.)	Gold (oz.)	Silver (oz.)
January	44,305	46,553	46,489	18,077
February	43,591	21,313	43,366	19,806
March	43,830	8,179	48,397	17,394
April	46,587	22,573	—	—
May	46,015	19,937	46,423	46,280
June	46,453	20,105	49,995	31,386
July	44,244	19,170	—	—
August	47,484	20,549	—	—
September	48,295	21,141	—	—
October	46,311	6,342	—	—
November	47,994	16,435	—	—
December	48,888	30,724	—	—

WESTRALIAN GOLD PRODUCTION

	1957	1958	1959
	Oz.	Oz.	Oz.
January	106,722	66,562	63,924
February	64,949	65,965	65,035
March	67,121	65,420	65,408
April	66,435	60,855	62,686
May	64,886	64,196	64,184
June	65,142	67,929	74,590
July	74,420	81,106	78,974
August	75,727	68,610	—
September	64,422	68,744	—
October	64,524	70,128	—
November	65,700	67,562	—
December	66,562	120,106	—
Total	846,610	867,187	—

AUSTRALIAN GOLD OUTPUTS

	4-Week Period			
	To Sept. 15		To Oct. 13	
	Tons	Oz	Tons	Oz.
Central Norseman	14,051	7,228	14,128	9,883
Crœsus Proprietary	—	—	—	—
Gold Mines of Kalgoorlie	39,981	10,831	41,007	10,930
Golden Horse Shoe*	—	—	—	—
Gt. Boulder Gold Mines*	—	—	—	—
Gt. Western Consolidated	35,555	5,822	33,031	5,100
Hill 50*	13,943	—	—	—
Kalgurli Ore Treatment	—	—	—	—
Lake View and Star*	—	—	—	—
Moonlight Wiluna*	—	—	—	—
Morning Star (G.M.A.)	862	631	363	616
Mount Ida*	—	—	—	—
New Coolgardie	—	—	—	—
North Kalgurli	28,347	—	28,725	7,149
Sons of Gwalia	12,278	—	12,796	3,220
Mount Morgan	—	3,893	—	4,246

*3 Months

ONTARIO GOLD AND SILVER OUTPUT

	Tons Milled	Gold Oz.	Silver Oz.	Value Canad'n $
May, 1958	801,102	228,590	35,712	7,789,644
June	775,384	228,123	37,535	7,745,425
July	750,410	228,960	42,275	7,740,144
August	740,459	218,126	38,940	7,355,406
September	771,115	202,798	31,543	7,006,517
October	801,965	209,006	34,914	7,178,218
November	783,065	230,251	35,097	7,842,435
December	787,573	219,351	30,989	7,490,094
January, 1959	799,178	227,656	41,277	7,700,672
February	727,843	227,981	32,976	7,798,523
March	807,952	223,728	33,045	7,616,425
April	776,583	225,027	32,778	7,712,425
May	791,199	227,924	34,006	7,713,970
June	768,725	213,486	31,692	7,178,823
July	774,749	221,814	32,172	7,498,030
August	683,819	191,598	29,141	6,428,545

MISCELLANEOUS GOLD AND SILVER OUTPUTS

	Sept.		Oct.	
	Tons	Oz.	Tons	Oz.
British Guiana Cons.	—	—	—	—
Central Victoria Dredging	—	—	—	—
Clutha River	—	662	—	—
Emperor Mines (Fiji)*	—	—	—	—
Frontino Gold (Colombia)	—	—	—	—
Geita Gold (Tanganyika)	—	—	—	—
Harrietville (Aust.)	—	—	—	—
Lampa (Peru)†	—	36,800	42,160	—
Loloma (Fiji)*	—	—	—	—
New Guinea Goldfields	3,525	1,595	—	—
St. John d'el Rey (Brazil)	—	—	—	—
Yukon Consol.	—	$309,000	—	$243,000

* 3 Months. † Oz. Silver: Copper, 84 tons: 114 tons.

OUTPUTS OF MALAYAN TIN COMPANIES IN LONG TONS OF CONCENTRATES

	Aug.	Sept.	Oct.
Ampat Tin	39	48½	41
Austral Amalgamated	—	—	—
Ayer Hitam	—	216*	—
Batu Selangor	—	—	—
Berjuntai	130	144	186
Chenderiang	—	32*	—
Gopeng Consolidated	—	—	—
Hongkong Tin	—	56*	—
Idris Hydraulic	—	34½*	—
Ipoh	—	56*	—
Jelapang Tin	—	—	—
Kampong Lanjut	43	45½	83
Kamunting	109	107½	93½
Kent (F.M.S.)	—	—	—
Kepong	—	—	—
Killinghall	—	69*	—
Kinta Kellas	—	—	—
Kinta Tin Mines	—	94*	—
Klang River	—	—	—
Kramat	66	53	24
Kuala Kampar	81	19½	54
Kuala Lumpur	—	—	—
Kuchai	—	—	—
Lahat Mines	—	—	—
Larut	—	—	—
Lower Perak	24½	30	66
Malayan	—	506*	—
Malaysiam	8	—	12½
Pacific Tin Consolidated	—	—	—
Pahang Consolidated	—	404*	—
Pengkalen	—	—	—
Petaling Tin	—	110*	—
Puket	—	—	—
Rahman Hydraulic	—	—	—
Rambutan	—	—	—
Rantau	40	39	38½
Rawang Concessions	—	—	—
Rawang Tin Fields	—	—	—
Renong	—	178*	—
Selayang	—	42*	—
Siamese Tin Syndicate (Malaya)	42	14	33
Southern Kinta	164½	149½	161
Southern Malayan	—	511½*	—
Southern Tronoh	—	—	—
Sungei Besi	—	175½*	—
Sungei Kinta	—	42*	—
Sungei Way	—	226*	—
Taiping Consolidated	14	15½	6½
Tambah	—	—	—
Tanjong	—	149*	—
Tekka	—	—	—
Tekka-Taiping	—	—	—
Temoh	—	9½*	—
Tongkah Compound	—	—	—
Tongkah Harbour	33	31½	30
Tronoh	—	516*	—
Ulu Klang	—	—	—

* 3 Months.

MISCELLANEOUS TIN COMPANIES' OUTPUTS IN LONG TONS OF CONCENTRATES

	Sept.		Oct.	
	Tin	Columbite	Tin	Columbite
Amalgamated Tin Mines ..	253	34	353	—
Anglo-Burma Tin *.....	125	—	—	—
Bangrin.....	23	—	51	—
Beralt	21	172†	14	175†
Bisichi	36	30	57	44
Ex-Lands Nigeria	41	—	50	—
Geevor.....	54	—	53	—
Gold and Base Metal	57	9	—	—
Jantar Nigeria	13	17	—	—
Jos Tin	12	—	—	—
Kaduna Prospectors	4	—	4½	—
Kaduna Syndicate.....	16	—	21	—
Katu Tin.....	30	—	31	—
Keffi Tin	—	—	—	—
London Nigerian Mines ...	—	—	—	—
Mawchi Mines	—	—	—	—
Naraguta Extended	10	—	13	—
Naraguta Karama.....	10	—	11½	—
Naraguta Tin.....	—	—	—	—
Renong Consolidated	—	—	—	—
Ribon Valley (Nigeria)	—	—	—	—
Siamese Tin Syndicate	63	—	85	—
South Bukeru.....	—	—	—	—
South Crofty	81	—	74	—
Tavoy Tin.....	—	—	—	—
Tin Fields of Nigeria.....	—	—	—	—
United Tin Areas of Nigeria	—	—	—	—

* 3 months. † Wolfram.

SOUTH AFRICAN MINERAL OUTPUT

August, 1959

Gold.....	1,733,346 oz.
Silver.....	179,165 oz.
Diamonds	239,067 carats.*
Coal	3,310,589 tons.
Copper.....	(*a*) — tons in matte and copper-gold concentrates. (*b*) 4,394 tons of 99·15%.
Tin.....	231 tons concs.
Platinum (concentrates, etc.)	—
Platinum (crude)	—
Asbestos	15,087 tons.
Chrome Ore	64,872 tons.
Manganese Ore	91,244 tons.
Lead Concs.....	— tons.

* *July, 1959.*

IMPORTS OF ORES, METALS, ETC., INTO UNITED KINGDOM

		Aug.	Sept.
Iron Ore	tons	1,206,039	1,318,143
Manganese Ore.....	„	45,385	22,480
Iron and Steel	„	46,857	25,203
Iron Pyrites	„	21,464	38,270
Copper Metal	„	35,921	38,027
Tin Ore	„	—	7,747
Tin Metal	„	4,955	45
Lead	„	9,363	11,829
Zinc Ore and Conc.	„	12,762	4,230
Zinc	„	12,594	17,096
Tungsten Ores	„	340	404
Chrome Ore	„	22,540	17,866
Bauxite	„	6,902	43,138
Antimony Ore and Concs.....	„	1,140	1,030
Titanium Ore	„	16,732	19,869
Nickel Ore	„	—	—
Tantalite/Columbite	„	20	21
Sulphur	„	30,580	26,736
Barytes	„	2,151	3,380
Asbestos	„	11,719	13,047
Magnesite	„	749	1,323
Mica	„	575	189
Graphite	„	326	920
Mineral Phosphates	„	81,479	99,087
Molybdenum Ore	„	480	552
Nickel	cwt.	123,314	99,591
Aluminium	„	485,111	374,099
Mercury.....	lb.	112,122	259,902
Bismuth	„	48,213	12,357
Cadmium	„	184,538	200,655
Cobalt and Cobalt Alloys	„	402,253	47,205
Selenium	„	19,648	21,785
Petroleum Motor Spirit	1,000 gals.	96,609	99,763
Crude	„	999,862	889,463

Prices of Chemicals

The figures given below represent the latest available.

		£	s.	d.
Acetic Acid, Glacial	per ton	106	0	0
„ „ 80% Technical	„	97	0	0
Alum, Comml.	„	25	0	0
Aluminium Sulphate.....	„	16	10	0
Ammonia, Anhydrous	per lb.		2	0
Ammonium Carbonate	per ton	59	0	0
„ Chloride, 98%	„	26	0	0
„ Phosphate (Mono- and Di-) ...	„	102	0	0
Antimony Sulphide, golden	per lb.		3	0
Arsenic, White, 99/100%	per ton	47	10	0
Barium Carbonate (native), 94%	„	Nominal		
„ Chloride	„	53	0	0
Barytes (Bleached)	„	20	0	0
Benzene	per gal.		5	2
Bleaching Powder, 36% Cl.	per ton	30	7	6
Borax	„	46	0	0
Boric Acid, Comml.	„	77	0	0
Calcium Carbide	„	40	17	9
„ Chloride, solid, 70/75%	„	13	5	0
Carbolic Acid, crystals	per lb.		1	6
Carbon Bisulphide.....	per ton	62	10	0
Chromic Acid (ton lots)	per lb.		2	2½
Citric Acid	per cwt.	11	0	0
Copper Sulphate	per ton	76	0	0
Creosote Oil (f.o.r. in Bulk)	per gal.		1	2
Cresylic Acid, refined	„		6	10
Hydrochloric Acid 28° Tw.	per carboy		13	0
Hydrofluoric Acid, 59/60%	per lb.		1	1
Iron Sulphate.....	per ton	3	17	6
Lead, Carbonate, white	„	116	15	0
„ Nitrate	„	116	0	0
„ Oxide, Litharge	„	106	15	0
„ Red.....	„	104	15	0
Lime Acetate, brown	„	40	0	0
Lithopone	„	56	10	0
Magnesite, Calcined	„	20	0	0
„ Raw	„	9	0	0
Magnesium Chloride, ex Wharf	„	16	0	0
„ Sulphate, Comml.	„	15	10	0
Methylated Spirit, Industrial, 66 O.P.....	per gal.		6	3
Nitric Acid, 80° Tw.	per ton	37	10	0
Oxalic Acid	„	129	0	0
Phosphoric Acid (S.G. 1·750)	per lb.		1	4
Pine Oil.....	per ton	Nominal		
Potassium Bichromate	per lb.		1	2½
„ Carbonate (hydrated)	per ton	72	10	0
„ Chloride	„	21	0	0
„ Iodide	per lb.		6	10
„ Amyl Xanthate	„	Nominal		
„ Ethyl Xanthate	„	Nominal		
„ Hydrate (Caustic) flake	per ton	118	0	0
„ Nitrate	per cwt.	4	1	0
„ Permanganate	per ton	193	0	0
„ Sulphate, 50%	„	20	5	0
Sodium Acetate	„	75	10	0
„ Arsenate, 58–60%.....	„	Nominal		
„ Bicarbonate	„	15	0	0
„ Bichromate	per lb.		1	0
„ Carbonate (crystals)	per ton	Nominal		
„ „ (Soda Ash) 58%	„	13	15	0
„ Chlorate	„	91	0	0
„ Cyanide 100% NaCN basis	per cwt.	6	6	6
„ Hydrate, 76/77%, solid	per ton	33	0	0
„ Hyposulphite, Comml.	„	32	15	0
„ Nitrate, Comml.	„	29	0	0
„ Phosphate (Dibasic)	„	40	10	0
„ Prussiate	per lb.		1	0½
„ Silicate	per ton	11	10	0
„ Sulphate (Glauber's Salt)	„	9	15	0
„ „ (Salt-Cake)	„	10	0	0
„ Sulphide, flakes, 60/62%.....	„	38	12	6
„ Sulphite, Comml.	„	27	15	0
Sulphur, American, Rock (Truckload).....	„	14	0	0
„ Ground, Crude	„	17	10	0
Sulphuric Acid, 168° Tw.	„	12	0	0
„ „ free from Arsenic, 140° Tw.	„	7	0	0
Superphosphate of Lime, 18% P_2O_5	„	14	18	6
Tin Oxide	„	Nominal		
Titanium Oxide, Rutile	„	172	0	0
„ White, 25%	„	85	0	0
Zinc Chloride	„	95	0	0
„ Dust, 95/97% (4-ton lots)	„	114	0	0
„ Oxide	„	101	0	0
„ Sulphate.....	„	32	0	0

Share Quotations

Shares of £1 par value except where otherwise stated.

GOLD AND SILVER:	Oct. 8, 1959 £ s. d.	Nov. 9, 1959 £ s. d.
SOUTH AFRICA:		
Blinkpoort (5s.)	4 11 3	4 12 3
Blyvooruitzicht (2s. 6d.)	1 9 3	1 10 9
Brakpan (5s.)	5 9	6 0
Buffelsfontein (10s.)	2 9 0	2 7 6
City Deep	1 1 6	1 2 6
Consolidated Main Reef	1 1 6	1 1 6
Crown Mines (10s.)	1 8 0	1 8 6
Daggafontein (5s.)	1 7 9	1 7 3
Dominion Reefs (5s.)	13 0	14 0
Doornfontein (10s.)	1 13 9	1 13 0
Durban Roodepoort Deep (10s.)	1 14 6	1 15 9
East Champ d'Or (2s. 6d.)	2 0	2 3
East Daggafontein (10s.)	8 9	9 6
East Geduld (4s.)	1 6 9	1 6 6
East Rand Ext. (5s.)	1 7 3	1 9 6
East Rand Proprietary (10s.)	2 3 6	2 2 3
Freddies Consol.	2 6	2 9
Free State Dev. (5s.)	9 9	6 3
Free State Geduld (5s.)	8 18 9	9 3 0
Free State Saaiplaas (10s.)	1 1 3	1 2 3
Geduld	3 11 3	3 15 0
Government Gold Mining Areas (3d.)	3 3	3 0
Grootvlei (5s.)	1 2 6	1 2 6
Harmony (5s.)	1 18 3	1 19 3
Hartebeestfontein (10s.)	3 2 3	2 19 3
Libanon (10s.)	15 0	15 3
Loraine (10s.)	1 13 9	1 16 6
Luipaards Vlei (2s.)	8 0	9 0
Marievale (10s.)	1 7 0	1 8 3
Merriespruit (5s.)	4 6	2 0
Modderfontein B (3d.)	2 6	2 6
Modderfontein East	17 0	17 0
New Kleinfontein	5 3	5 3
New Pioneer (5s.)	1 18 0	1 17 9
New State Areas (15s. 6d.)	1 6	1 3
President Brand (5s.)	3 19 3	3 18 3
President Steyn (5s.)	1 11 0	1 11 6
Rand Leases (9s. 3d.)	7 6	7 6
Randfontein	1 2 3	1 1 9
Rietfontein (3d.)	5 0	5 0
Robinson Deep (5s. 6d.)	7 0	7 0
Rose Deep (3s. 6d.)	10 0	10 0
St. Helena (10s.)	4 1 6	4 0 6
Simmer and Jack (1s. 6d.)	2 3	2 0
South African Land (3s. 6d.)	1 1 6	16 3
Springs (5d.)	2 3	2 3
Stilfontein (5s.)	1 19 6	1 19 9
Sub Nigel (3d.)	11 9	11 9
Vaal Reefs (5s.)	2 3 6	2 5 9
Van Dyk (3s.)	3 9	4 0
Venterspost (10s.)	16 3	19 6
Virginia (5s.)	5 3	5 0
Vlakfontein (10s.)	18 6	1 1 3
Vogelstruisbult (3d.)	7 3	7 3
Welkom (5s.)	1 2 9	1 1 6
West Driefontein (10s.)	7 18 0	9 11 3
West Rand Consolidated (10s.)	1 2 3	1 3 3
West Witwatersrand Areas (2s. 6d.)	3 12 9	3 14 9
Western Holdings (5s.)	8 8 6	8 4 0
Western Reefs (5s.)	1 5 3	1 11 3
Winkelhaak (10s.)	1 7 0	1 5 6
Witwatersrand Nigel (2s. 6d.)	1 3	1 3
Zandpan (10s.)	18 9	18 0
RHODESIA:		
Cam and Motor (2s. 6d.)	9 3	10 0
Chicago-Gaika (10s.)	17 6	1 0 0
Coronation (2s. 6d.)	4 9	5 0
Falcon (5s.)	9 6	10 0
Globe and Phœnix (5s.)	1 11 6	1 13 6
Motapa (5s.)	9	9
GOLD COAST:		
Amalgamated Banket (3s.)	1 3	1 6
Ariston Gold (2s. 6d.)	4 9	5 0
Ashanti Goldfields (4s.)	1 4 0	1 4 0
Bibiani (4s.)	4 6	4 0
Bremang Gold Dredging (5s.)	2 6	3 0
Ghana Main Reef (5s.)	3 0	3 3
Konongo (2s.)	1 9	1 9
Kwahu (2s.)	5 3	6 9
Offin River (2s. 6d.)	—	3 0
Western Selection (5s.)	6 0	6 0
AUSTRALASIA:		
Gold Fields Aust. Dev. (3s.), W.A.	2 6	1 6
Gold Mines of Kalgoorlie (10s.)	9 6	9 0
Great Boulder Propriet'y (2s.), W.A.	12 6	12 6
Lake View and Star (4s.), W.A.	1 7 0	1 7 0
Mount Morgan (10s.), Q.	16 9	18 6
New Guinea Gold (4s. 3d.)	1 6	1 9
North Kalgurli (1912) (2s.), W.A.	11 3	11 0
Sons of Gwalia (10s.), W.A.	2 9	2 6
Western Mining (5s.), W.A.	10 6	10 6

MISCELLANEOUS:	Oct. 8, 1959 £ s. d.	Nov. 9, 1959 £ s. d.
Fresnillo ($1·00)	1 9 6	1 10 6
Kentan Gold Areas	1 18 9	2 0 3
St. John d'el Rey, Brazil	2 17 6	3 5 0
Yukon Consolidated ($1)	5 6	6 0
COPPER:		
Bancroft Mines (5s.), N. Rhodesia	1 3 3	1 7 0
Esperanza (2s. 6d.), Cyprus	1 9	2 0
Indian (2s.)	4 9	4 9
MTD (Mangula) (5s.)	9 0	12 0
Messina (5s.), Transvaal	5 7 3	6 15 0
Mount Lyell, Tasmania	1 9 0	1 8 6
Nchanga Consolidated, N. Rhodesia	3 3 0	3 14 3
Rhokana Corporation, N. Rhodesia	30 15 0	39 5 0
Roan Antelope (5s.), N. Rhodesia	8 0	8 6
Tanganyika Concessions (10s.)	2 7 6	2 9 6
LEAD-ZINC:		
Broken Hill South (1s.), N.S.W.	11 0	11 9
Burma Mines (3s. 6d.)	2 0	2 0
Consol. Zinc Corp. Ord.	3 3 9	3 13 0
Lake George (5s.), N.S.W.	3 6	4 3
Mount Isa, Queensland (5s. Aust.)	2 9 3	2 17 9
New Broken Hill (5s.), N.S.W.	1 13 0	1 19 0
North Broken Hill (5s.), N.S.W.	4 6 0	4 15 0
Rhodesia Broken Hill (5s.)	10 0	11 6
San Francisco (10s.), Mexico	19 6	1 1 3
TIN:		
Amalgamated Tin (5s.), Nigeria	9 0	9 9
Ampat (4s.), Malaya	10 9	11 3
Ayer Hitam (5s.), Malaya	1 18 6	2 5 0
Beralt (5s.), Portugal	1 11 6	1 15 0
Bisichi (2s. 6d.), Nigeria	4 3	5 0
Ex-Lands (2s.), Nigeria	2 3	2 9
Geevor (5s.), Cornwall	1 1 6	1 3 0
Gold Base Metals (2s. 6d.), Nigeria	1 0	1 3
Hongkong (5s.), Malaya	4 9	5 9
Jantar Nigeria (3s.)	4 3	4 9
Kaduna Syndicate (2s.), Nigeria	2 0	2 9
Kamunting (5s.), Malaya	12 9	16 3
Malayan Tin Dredging (5s.)	1 4 0	1 11 6
Mawchi Mines (4s.), Burma	1 9	2 0
Naraguta Extended (5s.), Nigeria	1 0	1 0
Pahang (5s.), Malaya	6 6	8 0
Siamese Synd. (5s.)	9 3	10 3
South Crofty (5s.), Cornwall	5 0	5 6
Southern Kinta (5s.), Malaya	1 8 0	1 10 0
Southern Malayan (5s.)	16 0	18 9
Southern Tronoh (5s.), Malaya	13 6	13 9
Sungei Besi (4s.), Malaya	12 6	16 6
Sungei Kinta, Malaya	14 6	15 6
Tekka (12s. 6d.), Malaya	4 6	5 6
Tronoh (5s.), Malaya	18 9	1 4 3
United Tin Areas (2s. 6d.), Nigeria	1 0	—
DIAMONDS:		
Anglo American Investment	15 0 0	16 10 0
Consol African Selection Trust (5s.)	1 4 3	1 9 6
Consolidated of S.W.A. Pref. (10s.)	11 3	11 9
De Beers Deferred (5s.)	8 13 6	9 16 0
FINANCE, ETC.		
African & European (10s.)	4 8 6	4 8 0
Anglo American Corporation (10s.)	10 1 3	10 6 3
Anglo Transvaal 'A' (5s.)	2 3 9	2 8 0
British South Africa (15s.)	4 13 6	5 10 9
British Tin Investment (10s.)	1 1 6	1 6 3
Broken Hill Proprietary	2 16 0	2 18 0
Camp Bird (10s.)	12 6	13 6
Central Mining	3 17 6	4 11 9
Central Provinces Manganese (10s.)	1 9 3	1 10 6
Consolidated Gold Fields	4 4 0	4 16 6
Consolidated Mines Selection (10s.)	2 4 6	2 11 9
Corner House	—	1 3 0
East Rand Consolidated (5s.)	1 9	2 3
Free State Development (5s.)	9 9	6 3
General Exploration O.F.S. (2s. 6d.)	6 0	7 0
General Mining and Finance	7 1 3	7 2 3
Hendersons (4s.)	—	17 9
Johannesburg Consolidated	3 8 3	3 16 6
London & Rhod. M. & L. (5s.)	8 6	8 6
London Tin Corporation (4s.)	9 9	10 9
Lydenburg Est. (5s.)	18 3	19 3
Marsman Investments (10s.)	2 7	2 9
National Mining	2 6	3 0
Rand Mines (5s.)	5 2 6	5 7 9
Rand Selection (5s.)	2 18 6	3 4 6
Rhodesian Anglo American (10s.)	4 3 9	4 14 0
Rhodesian Corporation (5s.)	3 3	3 9
Rhodesian Selection Trust (5s.)	15 0	15 9
Rio Tinto (10s.)	2 5 0	2 7 6
Selection Trust (10s.)	5 17 6	6 6 9
South West Africa Co. (3s. 4d.)	17 6	17 6
Union Corporation (2s. 6d.)	3 15 6	3 17 6
Vereeniging	6 13 9	6 15 0
West Rand Inv. Trust (10s.)	3 5 0	3 7 6

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section abstracts of important articles and papers appearing in technical journals and proceedings of societies are given, together with brief records of other articles and papers; also notices of new books and pamphlets and lists of patents on mining and metallurgical subjects.

Electromagnetic Prospecting

A review of Scandinavian electromagnetic prospecting techniques is given by F. C. Frischknecht in *Mining Engineering* for September. After touching on the development of these methods in Scandinavia the author goes on to say that electromagnetic methods may be classified into two general groups. The one includes methods in which the source of the electromagnetic field remains stationary while the receivers are moved about to explore the area. The other includes procedures in which the energizing and receiving systems are moved together.

Essentially a fixed-source method consists of the measurement of electromagnetic fields about the source. The mutual coupling between the source and the earth is constant, but the mutual coupling between the receiver and the earth (unless the earth is homogeneous) and also between the source and the receiver changes at each station. The results are usually normalized by relating the field data to the calculated free space or primary field.

The Turam or *two-frame* is probably the most common fixed-source method. The energizing source is an insulated cable grounded at both ends or formed into a large rectangular loop. Measurements are taken along a traverse at 5-metre to 50-metre intervals using two small receiving coils, the lagging coil being placed at the position previously occupied by the leading coil. The complex ratio—*i.e.*, inphase and out-of-phase ratios—of the voltages induced in the two coils is measured. Operating frequency range is about 100 to 800 cycles per second (c.p.s.).

The Turam method and its modifications have a greater working depth than the other electromagnetic precedures used in ore prospecting. Under favourable conditions conductors have been located at depths of 200 metres to 300 metres. A modified Turam method with one of the electrodes grounded in the upper end of a plunging ore-body was used to follow the extension of this body to a depth of 200 metres beneath a layer of conducting schists.

The compensator method employs large energizing layouts similar to those used with the Turam method. The voltage induced in a single receiving coil is measured relative to a reference signal carried by a cable from the energizing source. Usually both the vertical and a horizontal component of the field are measured at each station at two or more frequencies in the range from 10 c.p.s. to 300 c.p.s. Interpretative procedures make it possible to estimate depth to conducting horizons. The compensator method is used chiefly to map horizons in sedimentary rocks, although it is sometimes employed in searching for flat-lying metallic-ore deposits. It is used in Scandinavia in searching for coal and similar economic resources of sedimentary origin. The method is well described in the literature and will not be discussed further here.

The cross-ring method utilizes a small portable energizing loop oriented with its plane roughly parallel to the ground. Two identical receiving coils are fastened together in a perpendicular arrangement, one oriented so that it is in the plane of the energizing coil. The complex ratio of the voltages induced in the two receiving coils is measured and the data are plotted directly in profile form without preliminary calculations. Short profiles (up to 100 metres long) can be measured by moving the receiving coils and holding the energizing coil in fixed position. Usual frequency is 3,500 c.p.s.

Depth range of the cross-ring equipment now in use is limited to some tens of metres.

Bore-hole electromagnetic methods have not been used widely in Scandinavia, but limited applications have been successful and additional work is planned by various organizations. A combination surface-hole method uses a single coil in the bore-hole as a receiver and a large low-frequency energizing loop or grounded cable placed on the surface of the ground. The complex ratio of the voltage induced in the receiving coil to the current in the energizing source is measured.

In a moving-source method changes in the mutual coupling between source and receiver are measured. The coupling between both the source and receiver and the earth (unless the earth is homogeneous) changes at each station, but the free-space coupling between source and receiver remains constant. Usually results are normalized in the instrument by relating the readings to the free-space coupling.

The most common moving-source method is the Slingram or *loop frame*, which utilizes a small portable energizing coil and one receiving coil. A reference voltage is brought from the energizing coil to the receiving coil by a cable. The ratio of the mutual impedance between the two coils in the presence of the earth to their mutual impedance in free space is measured by finding the complex ratio between the voltage induced in the receiving coil and the reference voltage. The coil spacing, held constant for each series of measurements, may range from 20 metres to 100 metres. Usually the coils are oriented so that they are coplanar and horizontal or (on steep slopes) parallel to the ground; however, in techniques used less frequently, the coils are held in

perpendicular positions or in vertical, coaxial, or coplanar positions. Operating frequency ranges from 500 c.p.s. to 3,600 c.p.s. The complex mutual impedance ratios are presented in the form of individual profiles or contour maps without preliminary calculations.

The maximum working depth for the Slingram method, using two horizontal coils, is equal roughly to the coil spacing. The greatest depth at which a poorly-conducting vertical ore-body will cause a significant anomaly may be less than one-half the coil spacing, but a large, horizontal, highly-conductive body at a depth of twice the coil spacing may give a significant anomaly. The working depth for using a perpendicular-coil arrangement is about the same or a little greater than with two horizontal coils, but with vertical coils it may be only half as great.

Cross-ring equipment is sometimes used in a moving-source technique simply by maintaining a fixed distance between energizing and receiving loops. The coil spacing used may range from 20 metres to 80 metres.

An airborne system having some similarity to the cross-ring method uses two perpendicular energizing coils whose planes are parallel to the axis of the aircraft. Two receiving coils are oriented in similar directions to the transmitting coils and are towed in a bird, which is positioned as closely as possible along the axis of the aircraft. A relatively large source-to-receiver distance of 200 metres or more is sometimes obtained by towing the bird in a second aircraft. The energizing coils are excited by two voltages of the same frequency but 90° out-of-phase with respect to each other, thereby creating a rotating or circularly-polarized free space or primary field. The complex ratio of the voltages induced in the receiving coils is measured. In the absence of conducting material this ratio is independent of the distance between aircraft and bird, axial rotation of the bird, and to a considerable extent other misorientations of the bird.

A moving-source method is used in conductivity logging of bore-holes. Frequencies in the order of 20,000 c.p.s. are used in a sonde having a coaxial Slingram arrangement. The coil spacing is some tens of centimetres ; hence the radius of investigation is quite small.

Before discussing certain aspects of various specific methods it is desirable to point out some of the relative merits of fixed-source and moving-source methods. With a fixed-source method two identical disturbing bodies do not, in general, give rise to equal anomalies because the free-space coupling between source and receiver (and hence the depth of penetration, the normal fields, and other factors) is unequal at successive stations. The shapes of the anomalies obtained with fixed-source methods, however, are relatively simple ; the anomalies tend to be similar in shape to magnetic anomalies.

When a moving-source technique is used the free-space coupling between source and receiver is constant ; therefore, two identical disturbing bodies give rise to equal anomalies. In general, however, anomalies obtained with a moving-source method are somewhat complicated because the coupling between the source and the conductors varies. An anomaly obtained with a moving-source method usually has more maxima and minima than one obtained with a fixed-source method. The additional maxima and minima in moving-source anomalies are sometimes referred to as edge effects because they occur near the edges of conductors.

Usually several conducting bodies in proximity are most easily located and defined by fixed-source methods because of their relative freedom from edge effects. When moving-source techniques are employed the occurrence of more than one shallow conducting body within a distance equal to or less than the source-to-receiver distance results in data that are very difficult to interpret correctly.

When edge effects are not too troublesome moving-source methods are often superior to fixed-source methods, since the importance of one anomaly compared to another is more easily evaluated. Edge effects are not too troublesome : (1) If the horizontal extent of the conducting units is somewhat larger than the source-to-receiver distance, (2) if depth of burial and separation between units is great, or (3) if the boundary between units of different conductivities is not abrupt.

With a moving-source method, if vegetation and terrain do not interfere with lines of sight or connecting cables, the source and receiver may be placed *broad-side* rather than *in-line* to the traverse. Edge effects are thereby reduced and, if the traverse is perpendicular to the strike, individual conductors among a group of several parallel linear conductors may be resolved more easily.

In areas that are very complex geologically, especially when graphitic schists and slates are involved, the horizontal range of fixed-source equipment may be limited greatly by high attenuation of the normal field and the results may be complicated by the mutual coupling between adjacent conductors. Measurements with a fixed-source method become very laborious and in interpreting the results it may be impossible to resolve all the separate conductors as distinct units. In such areas a contour map prepared from moving-source data may give the interpreter the most useful information. This is especially true when the purpose of the survey is to map geological trends rather than to locate individual ore deposits.

Among the fixed-source methods the radio-reference-signal system requires the fewest men to make the measurements. It offers an advantage over the Turam method in obtaining the fields directly instead of by calculation. These measured values are often more accurate than those obtained by calculation, especially in regions where the field is near zero and the ratios may approach zero or infinity.

However, the ratio curve is more sensitive to small features than the field curve. By considering the ratios, therefore, it is possible to detect weaker conductors with the Turam method than with the radio-reference-signal system. Also, since the magnitude of a field anomaly depends on the position of the disturbing body with respect to the cable and to other bodies, a field anomaly cannot be evaluated on the basis of its magnitude alone. Ratio anomalies, however, depend on the shape and not on magnitude of the field anomaly. Thus it may be advantageous to have the ratios as well as the fields.

The depth range and speed of operation of the cross-ring method are inferior to those of the Turam and radio-reference signal, but the cross-ring is sometimes the most useful for working out details of a group of shallow conductors in proximity to each other.

When a moving source is used cross-ring equipment has an advantage over Slingram because it

does not require a cable connexion from transmitting to receiving coil. Also the maintenance of a constant distance between the two coils is not critical unless response from the overburden is great. Results are not as easily interpreted as those obtained by the Slingram method because, in general, anomalies occur simultaneously in both the horizontal and vertical fields and thus the data are not related to any fixed reference.

Slingram methods, either ground or airborne, are probably less expensive per traverse kilometre than their counterparts in other systems. Slingram is especially adaptable to reconnaissance work because no large energizing layouts are necessary. When a sizable area is to be surveyed in detail by ground work the radio-reference signal may be nearly as inexpensive as the Slingram method, since the expense of laying out cables is partially offset by the fact that each set of measuring apparatus can be operated by one man.

For detailed work over areas of particular interest it may be advisable to use the method that yields the most information regardless of cost. In such cases one of the fixed-source methods will usually be chosen because of its greater sensitivity, depth of penetration, and resolving power. The variety of problems in prospecting is so great that any one of the systems discussed may be the best in a particular instance.

A reference signal from the cable is used to modulate the radio transmitter placed near the energizing layout. The voltage demodulated in a radio receiver located in the measuring apparatus is sent to a phase splitter and then applied as the reference voltage to each of two diode-transformer phase discriminators. The voltage induced in the receiving coil is amplified by a calibrated amplifier and fed to the phase discriminators. D.c. meters connected to the outputs of the phase discriminators then give the in-phase and out-of-phase components of the magnetic field at the receiver relative to the current in the energizing cable.

One of the airborne electromagnetic methods using ground energization utilizes essentially this same system, but with the output of the phase discriminators fed to two continuously recording meters.

A simple airborne-Slingram arrangement also uses this measuring system, except that the reference voltage is sometimes transmitted by a wire connexion. Also the normal or primary signal from the receiver is compensated for by a reference voltage, so that in the absence of conductors there is no signal voltage applied to the phase discriminators.

Germanium Occurrences in B.C.

The September issue of the *Western Miner and Oil Review* contains an article by F. C. Buckland entitled "Germanium in British Columbia." The author says that the low-lying plains along the north side of the Strait of Malaspina, in the vicinity of Lang Creek, south-east of Powell River, are underlain by thick sandstone-conglomerate-shale formations of Eocene age. The proved extent of this formation is about one mile by four miles and the possible extent about three miles by five miles. The present indicated thickness is about 1,500 ft. The sedimentary series is underlain by a weathered granite. The contact can be observed in the valley of Lang (Wolfson) Creek. Throughout these sediments there are seams and fragments of coal. Wherever fresh bright coal from the formations has been assayed it has been found to contain appreciable amounts of germanium. Except for the basal beds, directly overlying the granite basement, the enclosing sandstone and shale is essentially barren.

Germanium, according to the author, was first discovered about 1948 in the Powell River area by spectrographic work undertaken on the coals of B.C. by the University of British Columbia and the B.C. Department of Mines. Later, by exploration companies, germanium in minute quantities was discovered on spectrographic examination of prospectors' samples of zinc ore from the mountain ranges behind the Powell Lake area. This discovery was of no economic importance but confirmed the occurrence of germanium in the area.

Coal is a well-known precipitant of germanium and, immediately after the invention of the transistor, the United States and Canadian Governments and most universities undertook research on all known coals to investigate the occurrence of germanium in this host and to attempt to discover a large source. These large research and investigation programmes showed that low percentages of germanium, too low to be commercial, occurred in many coal seams. However, the coal occurrences in the Eocene beds near Lang Creek gave some extraordinarily high values in germanium and, with this knowledge, the Eocene beds near Lang Creek were prospected in late 1957 and early 1958.

Germanium-bearing coal fragments were located at that time in two different types of deposits in the series.

Geology

Sandstone-Type Occurrence.—Coal was found to occur as thin discontinuous lenses from 0·01 in. to 3 in. in thickness and, commonly, less than 10 ft. in length; also in chunks and pieces of coarse coal up to 3 ft. in diameter. This type of deposit is probably the result of coalification of logs and branches, etc., deposited with the sandstone. Deposits of this type will naturally be somewhat erratic but sufficient deposition was discovered to indicate that certain areas and beds might be of ore grade.

Shale-Type Occurrence.—Lenses of coal usually $\frac{1}{4}$ in. or less thick and a few inches long occur in a grey silty shale. Large chunks of coal are found intermittently.

Basal Beds.—In April, 1959, Dr. A. C. Skerl suggested an examination of the beds towards the base of the sedimentary series, these being of possible greater economic value than those at higher elevations. Immediately a discovery was made of a basal member of the series containing a high percentage of coal and containing germanium in the carbonaceous bed itself, as well as in the coal. Coal occurs on, or a few feet above, the granite basement in a brown to black carbonaceous bed of varying thickness up to perhaps 20 ft. The coal occurs in lenses and narrow beds in the formation from a few thousandths of an inch up to several inches in individual seams. This basal member has been designated as "Brown-bed"

by company engineers and has now been proved to occur over a very considerable lateral extent.

Initially a churn- and diamond-drilling programme was undertaken under the direction of Mr. Gordon Hilchey. Holes were widespread and drilled vertically into the low-dipping formations to determine their extent and values at various positions on the property (161 claims and fractions). All holes intersected germanium-bearing coals. The scattered nature of the coal fragments in the sandstones and the wide spacing of the holes (some at half-mile intervals) made it impossible to estimate any values or tonnages from this work, but it did indicate the widespread occurrence of high-grade coal fragments.

For the same reason—namely, that the coal fragments are scattered and irregularly spaced—drilling, except on a very close-spaced grid, could not be expected to give an accurate answer as to ore grades and tonnages.

Following this initial drilling a ¾-yd. Lima shovel and TD 14 International and D 6 Caterpillar bulldozers were put to work stripping the basal brown bed to explore the outcrop along its strike. At the same time further extensions were uncovered by hand work. The overburden is heavy and the outcrops can only be explored at a few places, but their continuous extent has been demonstrated by work at intervals along a strike length of over three-quarters of a mile. The assumption can probably be made that the basal brown beds or equivalent formations extend over most, if not all, of the sedimentary basin; thus offering very large areas for exploration and possible ore occurrences and tonnages.

Following exploration of the outcrops by diesel shovel and bulldozers churn drilling with 6-in. holes was recommended to explore the extension down the dip of the basal beds and the sandstones above them, all holes being terminated when the granite basement is reached.

Engineering Control at Gaspé Copper

An account of the work of the mining engineering department at Gaspé Copper Mines, Ltd., is given by J. B. Watts in a paper appearing in the *Canadian Mining and Metallurgical Bulletin* for September. The Gaspé company, a subsidiary of Noranda Mines, Ltd., is working a mining, milling, and smelting plant on the Gaspé peninsula, Quebec. The mine is extracting 8,000 tons of ore a day and the mill can handle 6,500 tons a day.

Routine services provided by the mine engineering department include all surface and underground surveying and mapping, preparation of working drawings, compilation of engineering reports, recommendations on ventilation, testing the mine air for carbon monoxide, research on mine equipment and its use, and the calculation of incentive bonus. Demand jobs from departments other than the mine department are done on request. Such jobs may be in the plant site, the town of Murdochville, or at the shipping points at Gaspé harbour or the St. Lawrence river.

Mine Surveying

The mine survey section consists of the chief surveyor and four two-man instrument parties. One party is assigned to development surveying, which comprises about 20% of the surveying requirement. Drives, with the exception of hanging-wall drives, are driven on line and grade established by survey plugs set on centre line at approximately 80-ft. intervals. In drives where extra width is required to pass large equipment the track is laid on centre, but in other drives clearance is afforded only on one side by placing the left rail on centre.

Rises for ore-passes, ventilation, and drainage usually are point-to-point drives of predetermined vertical angle and azimuth. Rise surveying is done by setting up the theodolite on a telescopic aluminium "rise bar" instead of on a tripod. Grade and direction are given by sighting through 1-in. internal diameter flat-steel washers hung from two survey points near the face.

A permanent roadway is being driven 40 ft. below the foot-wall of the "*C*" ore-body. Cross-cuts are driven to the ore at predetermined floor elevations. To date pilot openings have been driven to provide ventilation for the diesel equipment used in slashing out to size. Lines and grades are required for the pilot openings and must be renewed for the slashing operation.

The other three survey parties are assigned to production areas. Mining in the "*B*" and "*C*" zones is essentially by the room-and-pillar method. Prior to the present practice of mining the top slice of the stope as a full-face overcut, surveys were carried from stations in the hanging-wall of the ore-body. Following the adoption of the full-face overcut other methods of carrying survey stations had to be found. Because the working floors may be from 30 ft. to 100 ft. below the back, and since mobile equipment is used, survey stations on the back or on the floor are not practical.

A solution to the problem was found by establishing survey plugs in pairs, one on each side of the stope, within working distance of the face and about 3 ft. above the floor. A notched 4-in. lag screw is used in place of the usual stainless-steel spad. In practice plumbob cord is stretched between adjacent stations. The instrument is set over a rider on the cord a measured distance out from the pillar station and backsights are taken to the stations. From here the bench face is surveyed either directly or by way of a temporary point made necessary by distance or change of direction.

The mining cycle in a stope consists of drilling, blasting, shovel mucking, scaling, rock-bolting, and clean-up. Engineering control of the mining operations consists of the survey and mark-up in the field, followed by calculation and plot in plan and section in the office. Faces are available for survey during the rockbolting and drilling part of the cycle. Pressure-spray cans of paint are used for mark-ups in the mine. For distinction the mine supervisors,

geologists, and mine engineers use aluminium, red, and yellow paint respectively.

Until recently the elevation of stope backs has been surveyed directly or measured by dropping a tape from the working stage of a mobile scaling rig. This work is now being done by means of three helium-inflated meteorological balloons attached to a calibrated cord.

Each survey party is responsible for a specific beat in the mine and is expected to maintain the 30-scale general plans and the stope plans and sections. They also maintain a cumulative record of the ore broken in each heading, so this information is readily available to the chief surveyor for his monthly reports.

Shaft Plumbing

One shift only was required to plumb the vertical internal shaft and establish three survey stations on each of the five levels. All possible preparation was made in advance, but the primary requirement was a method which would provide a rapid check between the levels and the control station at the shaft collar while surveying was in progress.

The cage compartment of the internal shaft is 6 ft. 6 in. by 14 ft. 4 in. inside dimensions. Three plumb wires in the pattern of an isosceles triangle were dropped so that the corners were 1 ft. clear of the compartment timber. After shaft stagings had been placed at each level and the clearance rings dropped the crews on each level measured and check-measured the distances between the wires to one one-thousandth of a foot. These measurements were 'phoned to the control point at the shaft collar. When the measurements from all parties agreed within five one-thousandths of a foot instructions were issued to proceed with the angular measurements. The permanent survey stations on each level were then established by extending the triangle of the plumb wires into a quadrilateral, with the first permanent spad opposite to the apex of the isosceles triangle. During this operation the apex angle of the plumb wires was measured and 'phoned to the collar for comparison with other levels. A special calculation sheet was used by each crew, with specific instructions on procedure, and orders were given to proceed with the level station surveys only after all measurements had been accepted at the collar.

Mine Draughting

Draughting in this department is limited to operational drawings. Sketches from the mine planning committee and the mine production engineer are transferred to drawings for use by the surveyors and mine supervisors. Working plans of development and stoping are prepared by the draughtsman. Each survey party maintains the plans of its area.

Research and Ventilation

The research and ventilation section regularly consists of a research engineer and two assistants but uses survey helpers as required.

Mine ventilation requirements necessitate continuous study of the mine ventilation system. Where diesel units are used the regulations of the Quebec Department of Mines require that 75 cu. ft./min. of air per horsepower be supplied in addition to the basic mine requirements. Diesel units may be concentrated in relatively small areas of what is now an immense underground opening. Fresh air is delivered to the main ore-body through an independent downcast system outside the ore-body and dispersed through hanging-wall drives to the stoping areas. The air is then upcast through the workings to the exhausting air course. Weekly ventilation surveys to check air flow and the conditions of ventilation doors and stoppings are made by personnel working under the direction of the research and ventilation section. Special arrangements to ensure proper ventilation of development headings are recommended by this section. Weekly surveys make use of manometers, velometers, and smoke tubes to determine volumes of air moving at key points.

Besides the weekly ventilation survey three men from the survey-helper pool make daily tests for carbon monoxide concentration and report on the condition of ventilation stoppings and controls. The tests for carbon monoxide are taken with a simple tester composed of an aspirator and tube with readings from ten parts per million of atmosphere by volume. These tests are made at specified control points and in areas of equipment concentration. A permanent record is maintained in the engineering office. Tests of exhaust gases and scrubber efficiency are made of motors undergoing dynamometer tests before entering mine service. The research section is responsible for the design of a diesel exhaust scrubber which is giving improved results. The section makes recommendations on the regulation of the downcast air, gives information and recommendations on dust suppression, and maintains plans of the ventilation system.

Research tests are constantly being made on mining equipment and mining procedure. Drilling tests are run using various types and sizes of machines, rods, and bits. Tests to determine the handling and haulage efficiency and grade ability of haulage units are made as new units are considered. Research is done on blasting, using various types of powder, hole patterns, and burden.

Incentive Bonus

The mine's incentive bonus programme is supervised by one of the mine engineering staff. Most of the clerical work is done by other departments whose reports are funnelled through this department, where information for production reports and bonus calculations is extracted. Shift reports are checked for correct charge accounts and labour distribution before going to the accounting department.

Approximately 70% of the total man-shifts worked in the mine qualify for incentive bonus. Incentive bonus in development headings is normal, the crews being paid a set rate per foot of advance, tonnage slashed, or tonnage delivered to the ore-pass, as applicable. Special allowances are made for special conditions.

Stope contracts are grouped according to function and subdivided according to working zones. Thus the rate for jumbo drilling and blasting is based on holes drilled per shift. The rate for shovel operators and truck drivers is based on tonnage delivered to the ore-pass.

Other functions—such as, high-rig scaling, rock-bolting, and secondary clean-up—cannot be measured in terms of ore production. However, these are important parts of the mining cycle and the operators are paid a rate based on the quality of the work done, with safety the primary objective.

Pegmatite Tin in South-West Africa

A note by J. G. Dennis in *Economic Geology* for September–October is descriptive of cassiterite-bearing pegmatites occurring near Brandberg, South-West Africa. The deposits in question are situated north of the Brandberg on both sides of the Ugab River. The country rock consists of a thick sequence of intensely deformed Precambrian (Lower Damara) schists in which are emplaced late phases of Salem granite. It has been stated that the Damara system is the geosynclinal equivalent of the Otavi system farther north-east.

These metamorphosed and deformed rocks are unconformably overlain by the normally flat-lying volcanics of the Kaoko series, which is probably of Stormberg (late Karroo) age. Near their contact with the Brandberg granite the Kaoko beds dip inwards toward the granite. The Kaoko series consists of sediments and volcanics. There is even a thin fluvio-glacial conglomerate at the base of the sediments on the northern side of Brandberg. This means that Dwyka and Stormberg beds are represented. The age range is Permian to lower Jurassic. The Brandberg massif itself is a giant ring-dike pluton of late Karroo or possibly post-Karroo age, intruded in the older rocks. The schists are a thick sequence of pelitic and semipelitic rocks with interbedded marbles, amphibole schists, and quartzites ; they have remarkably uniform south-easterly dips. A number of isoclinal folds reveal a regional plunge of about 15° south-west. Lineations formed by the intersection of the dominant-fracture system and bedding are usually parallel to the axis of folding. Schistosity is generally parallel to isoclinally-folded bedding in this area but transects the apices of folds.

The minerals of the " white " granites are oriented completely at random, pegmatites within the granite occurring mainly as schlieren. Surrounding the random-oriented core there is a layered zone 200 ft. to 300 ft. wide of alternating fine-grained (aplitic) and coarse-grained (pegmatitic) material ; the layering dips about 70° north-west. Going out toward the schists septa of schist begin to appear parallel to the layering. These septa increase in width and number going outward, until the aplo-pegmatitic material is separated into zoned 10 ft. to 12 ft. wide dykes parallel in attitude to and emplaced in the dominant set of regional fractures. These facts suggest that the septa are undisturbed bands of the country schist. The distance between dykes gradually increases while their width decreases and, 2 to 3 miles away from the main body of white granite, they are very widely spaced, at intervals of hundreds of feet and more (though some occur in more closely-spaced groups) and are commonly no more than 2 ft. thick. It is important to note that the layering in the granite, the attitude of the schist septa, and that of the inner group of dykes are all parallel to one another and to the dominant regional fracture set.

It would seem that the pegmatites were emplaced at the same time as the main granite body to which they are related and that they are not late differentiates. In many cases they are cut and displaced by aplites. The pegmatites fall into three types, according to their occurrence in three belts : The inner belt, adjacent to the parent granite ; the intermediate belt, and the outer belt, farthest from the parent granite. The inner-belt pegmatites range from 12 ft. to 20 ft. in thickness. They actually consist mainly of aplitic material, with a few zones of large microcline phenocrysts. There are a few quartz cross-stringers containing grains of limonite of uncertain derivation. The aplitic zones are dotted with small red to brown garnets, as well as a little accessory apatite, tourmaline, and muscovite. No cassiterite has ever been found in the inner belt. These dykes are almost invariably in west-dipping fractures.

The intermediate-belt pegmatites are thinner than those of the inner belt, ranging from about 6 ft. to 15 ft. in thickness. They may contain feldspar-phenocryst zones, but consist mainly of aplitic material. Many of these dykes have sporadic central quartz zones, especially those near the outer fringe of the intermediate belt. There are also quartz-filled cross-fractures. Unlike the inner belt this belt has no garnets, but is characterized by maximum development of tourmaline and by sporadic greisenization in the pegmatites. In many places cassiterite occurs in these altered patches. Structural control here is similar to that of the inner belt, but pegmatites are also commonly found in east-dipping fractures. The outer-belt pegmatitic dykes are thin ; their width ranges from 1 in. or less to about 6 ft. They consist almost entirely of fine-grained aplitic material with a few central quartz zones. In addition quartz is common in cross-stringers. Tourmaline is absent and large microcline phenocrysts are rare. Here any cassiterite mineralization is confined to the central quartz zones and to the quartz cross-stringers. Structural control of the pegmatites is rather loose in this belt. Most of the dykes are in the dominant west-dipping strike fractures and in the conjugate set of east-dipping fractures, but a number of them follow entirely unrelated fractures.

Throughout these areas the concentration of pegmatites decreases outward from the granite. Where dykes pinch out they grade in many cases into quartz veins.

Field evidence appears to favour a replacement origin of the pegmatite dykes and of their parent granite body. Together they occupy a sizable volume, yet the country rock is not in any way disturbed by them. Similarly the gradual " disintegration " of the main granite body into dykes around its periphery, as described above, would favour a replacement origin by metasomatizing solutions that entered along fractures. Near the centre of metasomatic activity these solutions followed many closely-spaced fractures ; the dykes grew laterally and soon merged into a continuous granite body. Toward the periphery of activity fewer fractures admitted the fluids, less fluid was available, and the dykes were not able to coalesce.

Cassiterite mineralization occurs in two distinct ways : (1) Much is associated with greisenization or sericitization, as in the intermediate belt. Cassiterite in this association normally occurs as small black grains (each about 2 mm. and generally less than 8 mm. in diameter), not readily distinguishable visually from the ubiquitous tourmaline grains. (2) The remainder occurs as grains in quartz zones and stringers within pegmatites, as in the outer area. Here the cassiterite grains are normally reddish brown, rarely black. Their size ranges from about 2 mm. to 20 mm.

Intermediate-belt mineralization is associated with patches of pneumatolytic alteration (greiseniza-

tion). All cassiterite grains are black, rarely more than 20 mm. in diameter, and generally much less. It seems possible that these patches are merely outcrops of elongated shoots.

This possibility can only be investigated by actual mining. Cassiterite mineralization is preferentially in apophyses of the pegmatite dykes, small satellite lenses, and similar structure. It is almost invariably accompanied by tourmaline. This type of mineralization occurs at Kubugabis and at Brandberg North.

The outer belt is mineralized in the Human's Well area only. Cassiterite here occurs as reddish grains in central quartz zones and cross-cutting quartz stringers. Most pegmatites of this group carry a few scattered grains of cassiterite, but only a few carry concentrations of possible economic interest. Central quartz zones and cross-cutting quartz stringers were never observed together.

Cassiterite also occurs in quartz lenses, generally close to and evidently directly associated with mineralized pegmatites. In many places outer-belt pegmatites grade into quartz veins. Chlorite may be an accessory mineral in this type of mineralization. Outer-belt mineralization is more evenly distributed than intermediate-belt mineralization. Its concentration in a given pegmatite is, however, very low. Mineralization is best in the dominant west-dipping fracture set.

A number of the dykes described have been mined for cassiterite. However, alluvial concentrations related to the occurrences have proved far more rewarding and even these are mostly marginal. With more promising prospects throughout the neighbouring region the marginal prospects of the Kubugabis-De Rust area are not likely to be exploited in the foreseeable future.

Trade Paragraphs

Moxey, Ltd., of Birmingham Road, West Bromwich, announce that this will in future be the address of their office, the telephone number being West Bromwich 1971.

Aero Service Corporation, of Philadelphia, and their affiliates Canadian Aero Service, Ltd., have changed the address of their European office from 20, Albert Embankment, London, S.E. 11, to Avenida America 2-11°B, Madrid.

Sheffield Wire Rope Co., Ltd., of Darnall, Sheffield, announce that Mr. L. B. Devins has been appointed general manager. He was formerly sales manager of the steel-rope department of Wright's Ropes, Ltd. The Sheffield company was recently acquired by the Firth Cleveland Group and is celebrating its golden jubilee this year.

North British Rubber Co., Ltd., of Castle Mills, Edinburgh, announce the appointment of Mr. C. Thomson as sales manager, conveyor belting. Prior to joining North British in 1958 Mr. Thomson spent four years as an independent consultant, working mainly on new projects in the field of conveyors and material transport for the Coal Board and engineering companies.

Allis-Chalmers International, of Milwaukee, Wisconsin, recently announced the purchase of an Italian firm for the manufacture of crawler tractors and spare parts, Allis-Chalmers Italiana, S.p.A., a subsidiary of the parent firm in Milwaukee, having acquired the factory and crawler tractor business of Vender, S.p.A., in Cusano, a suburb of Milan. It produces crawler tractors ranging from 60 to 325 h.p.

W. J. Jenkins and Co., Ltd., of P.O. Box No. 3, Retford, Notts., issue an illustrated leaflet describing the Teska dense-medium washer for cleaning large and medium size coal. As to the design they state that the success of the S.K.B. drum washer has led to the development of a new type of separator incorporating the static end weirs which are extended to form troughs and retaining a narrower form of the rotating drum, which now functions as a shale extractor only.

Matthew Brothers, of Matbro Works, Sandy Lane, North, Wallington, Surrey, call attention to their four-wheel drive loader—known as the Mastiff, which is illustrated here. The machine, equipped with a 96-h.p. engine, is of 1½ cu. yd. capacity and is,

Matbro Mastiff Loader.

as will be seen, rubber-tyred, of the tractor-loader type, and has four-wheel steering. It has a standard-torque converter, power-shift transmission, and power steering. In a more recent announcement they state that a new company—**Matbro, Ltd.,** of Horley, Surrey—has taken over the loading shovel and fork-lift side of the business at a new works which has opened for this purpose.

Perkins Engines, Ltd., of Peterborough, have developed a new 60-b.h.p. industrial diesel engine. This is a four-cylinder unit to be known as the Four 203. For certain types of variable-speed applications such as in mobile cranes requiring 2,000 to 2,400 r.p.m. the unit is available with a hydraulic governor, developing up to 60 b.h.p. at the top speed. Fitted with a mechanical governor it develops up to 47 b.h.p. at 2,000 r.p.m.; the maximum torque at 1,350 r.p.m. is 151 lb. ft. An almost identical version of this engine, known as the Four 192 develops 45 b.h.p. at 2,000 r.p.m. continuous rating and 58 b.h.p. at 2,400 r.p.m.

Head, Wrightson and Co., Ltd., of Stockton-on-Tees, announce that an order has recently been received from the Denver Equipment Co. for three classifiers, valued at £19,163, to be installed at a copper mine in Haiti to handle 500 short tons of copper ore per day. The installation is part of a new development project at the mine to increase production and the classifiers will be of the 66-in. simplex double-pitch submerged type with a tank length of over 35 ft. and a spiral speed of 3½ r.p.m. The classifiers will overflow all *minus* 100 mesh copper ore and this particular type of grading equipment has been supplied by Head Wrightson to many metal mines throughout the world.

Consolidated Pneumatic Tool Co., Ltd., of 232, Dawes Road, London, S.W. 6, state that the recent announcement of the integration of the Reichdrill Manufacturing Co. Ltd., with the Consolidated Pneumatic Tool Co. Ltd., has been followed by further details of the re-organization involved. Mr. Robert C. Paul, managing director of Reichdrill Manufacturing, will now head the Reichdrill Division of the Consolidated Pneumatic and operate in co-operation with their contracting department from the company's head office. All manufacturing operations and spares will be transferred to the Consolidated Pneumatic works at Aberdeen. At the same time the Reichdrill head office and works at Wishaw, Scotland, and sales office at Clarges Street, London, have ceased to operate.

British Ropes, Ltd., of Doncaster, issue some interesting notes refering to some 4,500 miles of rope weighing 850 tons which will go into the making of the main cables of the River Tamar suspension bridge. This £200,000 order recently placed with the company comprises 62 separate ropes each about 2,200 ft. in length. The Tamar Bridge, it is believed, will be unique in that for the first time in England, locked coil ropes will be utilized for main suspension cables. Each rope is 2·37 in. diameter and calls for extremely accurate manufacture and prestressing. All these operations will be carried out at the company's Doncaster plant and manufacture was due to commence in October. The bridge, for which the Cleveland Bridge and Engineering Co., Ltd., are the main contractors, will form a vital highway link in the West Country and relieve traffic congestion on the Devon-Cornwall border.

Dowty Mining Equipment, Ltd., of Ashchurch, Glos., have recently granted an eight-year contract for the manufacture under licence in Japan of their hydraulic roof-support equipment for coal mines to Nihon Koki Kabushiki Kaisha, of Tokyo. The terms of the agreement give selling rights for Dowty mining equipment in Japan and other Far East countries. Japanese engineers are now visiting the company's factory at Ashchurch to study production methods. Geological conditions in Japan and consequently methods of coal extraction, it is pointed out, are somewhat similar to those in this country. Approximately 60% of the total annual output of about 55,000,000 tons is won from longwall faces on which hydraulic supports could be used, but the majority are still supported with wooden or steel props. Increased use of the coal cutter and the plough must lead to the introduction of modern roof-control methods and Japanese mining engineers are favouring hydraulic roof-support systems.

Henry Wiggin and Co., Ltd., of Thames House, Millbank, London, S.W. 1, have added Nimocast 713C to their range of nickel-chromium casting alloys. This is the equivalent of Inconel 713C, an investment casting alloy for high-temperature service developed in the research laboratories of the International Nickel Company, Inc., and already specified for the turbine-rotor blading of a number of U.S. gas-turbine aero-engines. Combining outstanding strength with excellent resistance to thermal fatigue at temperatures up to 980° C, it is of interest as a possible alternative to wrought alloys, which offer difficult production problems when developed for service at such elevated temperatures.

Nimocast 713C is readily castable and develops its best properties when cast in vacuum. Alternatively, it can be cast under a protective atmosphere such as argon. A heat treatment of two hours at 1,170° C. followed by air cooling is beneficial but not essential, unless the maximum mechanical properties are required.

Knapp and Bates, Ltd., of 14–17, Finsbury Court, Finsbury Pavement, London, E.C. 2, are now able to give details of their range of dry concentration equipment which includes Aero jigs, Vibrair tables, and, in association with J. R. F. Joyce, Ltd., the Joyce-Martienssen separator. This range, of which the Aero jig and the Joyce-Martienssen separator are rougher concentrators, has been designed for use in waterless regions, but in favourable circumstances up to 4% moisture can be accepted in the material to be handled. The Aero jig will handle material of *minus* 12 mm. and the Joyce-Martienssen separator that of *minus* 2 mm. *plus* 200 mesh, with ratios of concentration from 50 : 1 up to 800 : 1 according to the nature of the feed. The Vibrair table will produce marketable concentrates from the rougher concentrates of the two rougher machines and will separate by specific gravity difference on a sized feed, by size on an unsized feed of uniform density, or by particle shape on a sized feed of approximately uniform density. This gives great flexibility in operation and enables separations to be made which are difficult or even impossible by other means.

Hunslet Engine Co., Ltd., of 125, Jack Lane, Leeds, announce a new 204-h.p. diesel hydraulic locomotive which is of 0–6–0 type with a weight in working order of 30 tons. It is powered by a Gardner type 8L3 diesel engine and fitted with the company's patent hydraulic transmission in place of the four-speed mechanical gearbox previously

employed. By this means a starting tractive effort of no less than 20,700 lb. is achieved with an attractive performance through two speed ranges up to a maximum of 12 m.p.h. The torque converter is of a simple single-stage type, requiring virtually no maintenance. Designed for a relatively low torque multiplication it is capable of long continuous slow-speed working with heavy loads. Other features are the central position of the cab, which enables the floor to be completely flat and gives unobstructed movement between the driving positions on either side, and the controls, which are duplicated on both sides of the cab, are power assisted, and are conveniently mounted on a desk facing the short end of the locomotive. They include a powerful straight air brake which actuates cast-iron brake blocks on all six wheels. A converter/fixed drive control is also provided so that use of the converter can be dispensed with at will and the full power of the diesel engine used to assist braking.

Holman Bros., Ltd., of Camborne Cornwall, announce an expansion of their activities in the Midlands. Based on Birmingham and occupying new premises the company's branch will have a large selling and servicing organization and will deal with all Group products—*i.e.*, the products of the parent company and those of the subsidiary companies, Climax Rock Drill and Engineering, Ltd., Maxam Power, Ltd., Goodyear Pumps, Ltd. and Dustuctor Co., Ltd. The branch which is accommodated in a new building at Lightning Way, Alvechurch Road, West Heath, Birmingham, 31, was opened last month and comprises an office block with an area of 1,220 sq. ft. and stores servicing and workshop areas extending over 2,800 sq. ft. Further expansion has been allowed for in the design for the addition of a second storey to the office block and the expansion of the stores and works area by over 4,000 sq. ft. An exhibition was staged of a comprehensive range of Holman Group products including the " Rotair 600 ", the first British portable rotary screw-type compressor, now in full production at Camborne, and some examples of the uses of Maxam equipment for automatic and semi-automatic process control systems. The company has been actively engaged in the Midlands for over 70 years with a head office in Sheffield and sub-offices in a number of other centres.

Nordberg Manufacturing Co., of Milwaukee, Wisconsin (London office : 19, Curzon Street, W. 1), issue some notes on the Symons " Protecto-Lube " system primarily designed for Symons cone crushers and available with new units which can also be adapted to crushing and processing equipment already in the field. Lubricant to the equipment is under constant controllable pressure and temperature and filtered before returning to the oil circulating system. Built in three sizes, the units are available for 10, 25, and 50 gallons per minute output with an available operating range of 20% above and below this figure based on 500 seconds Saybolt Universal lubricating oil at 100° F. and 50 p.s.i. pump outlet pressure. The system is climatized for any conditions—tropical, temperate, or frigid. Where ambient temperature or operating conditions result in return oil temperatures above 120° F. it can be equipped with an efficient multipass cooler. With standard cooler equipment and with cooling water temperatures as high as 85° F. to 90° F. adjustment of water supply will permit cooling of the full oil flow from 140° F. to below 125° F. With colder water the temperature differential will be proportionately greater. In areas where severe cold weather is a problem the oil temperature in the tank may drop below the flow point of the oil and for such conditions the system can be supplied with a thermostatically controlled heater. If oil pressure to the lubricated machine should fall below the safe limit a green control light goes out and a warning horn sounds. This warning control circuit may be used for electrically interconnecting the starters of drive motors, feeders, crushers, etc., and to shut down such equipment automatically when oil pressure fails or drops below safe operating levels. The temperature of return oil from the lubricated machine is also automatically controlled.

Lafarge Aluminous Cement Co., Ltd., of 73, Brook Street, London W. 1, the manufacturers of Ciment Fondu, have been appointed main distributors of the first British-made super sulphated cement. This is made by the Frodingham Cement Co., of Brigg Road, Scunthorpe, from a granulated slag of unusually consistent composition and emanates from the works of Appleby Frodingham Steel Co., a branch of United Steel Companies, Ltd. Frodingham super sulphated cement hardens at approximately the same rate as portland cement and it has a very high resistance to sulphates, sea water, oils, fats, and dilute acids. The very low heat of hydration makes it particularly suitable for mass concrete work even under hot or tropical conditions.

Ransomes and Rapier, Ltd., of Ipswich have received an order from Calgary Power, Ltd., Alberta, for a large electrically-driven walking dragline. This the company regard as a great triumph for British engineering, it being the first time a contract for this type of machinery has been placed in Great Britain for delivery to the North American continent. The Canadian order is for a new machine recently introduced into the company's range of walking draglines which are specially designed for open-cast mining operations. The machine known as the RapieR W1350 weighs 1,400 tons and will be equipped with a 33-cu. yd. bucket capable of carrying 50 tons of material at a time at a radius of 215 ft. It will be manufactured at Waterside Works and, after dismantling into suitable units, shipped to Canada *via* Vancouver and then taken through the Rockies by rail to the assembly area at Wabamun near Edmonton and is expected to be working by the middle of 1962 for use in overburden removal.

The very low temperatures in which the machine must work in winter-time sets many interesting problems of design and construction. Special steels will be used to meet these conditions. As much as 82° of frost have been recorded in the area. Calgary Power, Ltd., are a utility company owning and operating thermal and hydro-electric power stations covering the whole Province of Alberta. This order for British-built equipment is, it is pointed out, the direct result of periodic visits to Canada by engineers from Ipswich who have studied the conditions in Canada and have persuaded Canadian engineers and American consultants to come to this country to see for themselves the great strides made in the design and construction of the world's largest dragline excavators, several of which have been employed in the iron-ore fields in Northamptonshire and Lincolnshire for many years. What is more important, it also demonstrates that this country can now successfully compete with American manufacturers not only in Canada, which for many years has been their own happy hunting ground, but in export markets generally.

Chloride Batteries, Ltd., of Clifton Junction, Swinton, Manchester, announce the introduction of a new range of Chloride Plante batteries which give a higher performance from a smaller lighter cell. It was in the year 1859 that Gaston Plante developed the first practical secondary cell and it is perhaps fitting that this new development should be announced in the centenary year. The outstanding features of these new cells are a saving in space of up to 50%, compared with cells made to BSS. 440, with a reduction in weight. They have a lower internal resistance and a greatly-improved performance at high rates of discharge, ranging from an increase of approximately 14% at the 1-hour rate to 100% at the 3-second rate of discharge. The positive plates are of improved Plante design and are worked in conjunction with negative plates of the pasted type. Separators are of Porvic 2, a development of the microporous plastic which is virtually indestructible in service. The new cells have been designed for stand-by duties entailing discharge rates between the 3-hour rate and the very high rates demanded for switch-closing purposes. There are 14 different sizes in the new range, with capacities from 15 Ah to 400 Ah at the 10-hour rate of discharge.

Another announcement refers to a significant advance in traction-battery design embodied in the new Exide-Ironclad battery with " gauntlet " plate construction, which gives 35% more power in the same space and for about the same weight. In the operation of mining locomotives practical benefits accrue : Batteries of greatly-increased capacity can be fitted in existing battery tanks and a higher capacity/weight ratio is obtained. The outstanding feature is the multi-tubular gauntlet of resin-impregnated Terylene cloth which is slipped over the spines of CB. 95 alloy of the positive plate and holds the active material in a grip that is not only firm but elastic. That used has a tensile strength of more than 40 tons per sq. in. and it is capable of sustaining an extension of 80%. The bottom of the positive plate is a polythene moulding designed to ensure that the tubes of the Terylene gauntlet are effectively and permanently sealed. It also has the advantage of serving as an insulator and is not subject to corrosion. The negative plates are armoured with sleeves of Porvic, which eliminates the possibility of internal short circuits and enables them to meet the demands of increased output. The cell containers are moulded from toughened hard rubber, thus obviating the risk of leaking cells and minimizing damage from road shocks, vibration, and rough treatment. Combined spray arrestors and separator guards moulded in polystyrene are incorporated.

RECENT PATENTS PUBLISHED

☛ A copy of the specification of the patents mentioned in this column can be obtained by sending 3s. 6d. to the Patent Office, Southampton Buildings, Chancery Lane, London, W.C. 2, with a note of the number and year of the patent.

37,281 of 1955 (819,870). Dominion Magnesium, Ltd. Metal retorts for the production of alkaline earth metals by thermal reduction under reduced pressure.

9,462 of 1956 (820,119). Union Carbide Corporation. Process for the production of metals.

9,978 of 1956 (820,630). Metallhütte Mark A.-G. Refining of aluminium.

26,347 of 1956 (820,574). P. Willems. Physical and chemical treatment of minerals, etc.

37,658 of 1956 (819,219). Huntington Heberlein and Co., Ltd. Sintering process and apparatus.

6,769 of 1957 (819,329). Westfalia Dinnendahl Gröppel A.-G. Cone crusher.

33,153 of 1957 (819,412). Vereinigte Aluminium-Werke A.-G. Method and apparatus for the recovery of magnesium.

8,796 of 1958 (819,597). Babcock and Wilcox, Ltd. Tube mills.

NEW BOOKS, PAMPHLETS, ETC.

☛ Publications referred to under this heading can be obtained through the Technical Bookshop of *The Mining Magazine*, 482, Salisbury House, London, E.C. 2.

The Study of Rocks in Thin Section. By W. W. Moorhouse. Cloth, octavo, 514 pages, illustrated. Price 63s. New York : Harper and Brothers.

Winding and Transport in Mines. By John Sinclair. Cloth, octavo, 370 pages, illustrated. Price 60s. London : Sir Isaac Pitman and Sons, Ltd.

The Key to Costing and Accounting : A graphical elucidation for technical and business men. By J. A. R. Tainsh. Cloth, small octavo, 119 pages, illustrated. Price 14s. London : Charles Griffin and Co., Ltd.

The Report of the National Chemical Laboratory, 1958. Paper covers, 97 pages, illustrated. Price 5s. 6d. London : H.M. Stationery Office.

Estimated World Crude Oil Production and Refining Capacity, 1958 : P.I.B. Wall Map. Price 2s. London : Petroleum Information Bureau.

Bechuanaland Protectorate : The Morapule Coalfield, Palapye Area. Geological Survey Department Mineral Resources Report No. 1. By O. S. van Straten. Paper covers, 50 pages, with maps. Price 5s. Lobatsi : Geological Survey.

Western Australia : Miscellaneous Reports for 1954, Supplementary Atlas. Geological Survey Bulletin No. 109, Part 2. Paper folio. Perth : Government Printer.

New South Wales : Department of Mines Technical Reports, Vol. 4, 1956. Paper boards, folio, 144 pages, illustrated. Sydney : Government Printer.

British Guiana : Report on the Geological Survey Department for the year 1958. Paper covers, 56 pages. Price $1.00. Georgetown : Geological Survey Department.

Kenya : Mines and Geological Department Annual Report, 1958. Paper covers, 18 pages, with map. Price Shs. 2/50. Nairobi : Government Printer.

Le Précambrien de la Frontière Occidentale du Cameroun Central. By Pierre Koch. *Bulletin de la Direction des Mines et de la Geologie* No. 3. Paper covers, 300 pages, illustrated. Paris : Librairie Thomas.

Bulletin Géologique de la Nouvelle-Calédonie : No. 1. Paper covers, 203 pages, illustrated. Paris : Librairie Thomas.

Recherche Géologique et Minérale en Polynésie Française. Paper covers, 60 pages, illustrated, with maps. Paris : L'Inspection Générale des Mines et de la Géologie.

Selected Index to Current Literature

This section of the Mining Digest is intended to provide a systematic classification of a wide range of articles appearing in the contemporary technical Press, grouped under heads likely to appeal to the specialist.

* Article in the present issue of the MAGAZINE. † Article digested in the MAGAZINE.

Economics

Coal, Fine : *Utilization, Briquetting.* Briquetting in the Beneficiation of Fine Coal. E. SWARTZMAN, *Canad. Min. Metall. Bull.*, Sept., 1959.

India, Industry : *Iron, Steel.* The Iron and Steel Industry in India. G. R. BASHFORTH, *Iron, Coal Tr. Rev.*, Oct. 23, 1959.

Manganese, India : *Manufacture, Ferromanganese.* India Expands Ferromanganese Industry. L. NAHAI, *Engg. Min. J.*, Oct., 1959.

Metals, Light : *Progress, Review.* Light Metals—Production and Performance. W. L. RICE, *Min. Engg.*, Sept., 1959.

Power, Canada : *Resources, Review.* Present Status of Canadian Energy. C. L. O'BRIAN, A. W. LOVETT, *Canad. Min. Metall. Bull.*, Sept., 1959.

***Production, Canada :** *Gas, Alberta.* Natural Gas in Alberta. H. L. HOLLOWAY, THE MINING MAGAZINE, Nov., 1959.

Production, Canada : *Mineral, Nova Scotia.* The Mineral Industry of Nova Scotia, 1958. D. H. STONEHOUSE, *Canad. Min. Metall. Bull.*, Sept., 1959.

Resources, British Guiana : *Sand, Glass.* Report on British Guiana White Sand as a Possible Source of Glass Sand. R. A. DUJARDIN, *B.G. Geol. Surv. Min. Resources Pamphlet* No. 8.

†Resources, Canada : *Germanium, B.C.* Germanium in British Columbia. F. C. BUCKLAND, *Western Miner*, Sept., 1959.

Resources, Hungary : *Manganese, Review.* Manganese Deposits of Hungary. M. DRABINA-SZABO, *Econ. Geol.*, Sept–Oct., 1959.

Resources, United States : *Aggregate, California.* Franciscan Chert in California Concrete Aggregates. H. B. GOLDMAN, Calif. Div. Mines Special Report 55.

Geology

Carbonatite, Africa : *Study, Tanganyika.* Additional Data on the Geology of the Mbeya Carbonatite. L. J. FICK, C. VAN DER HEYDE, *Econ. Geol.*, Aug., 1959.

Economic, Africa : *Coal, Rhodesia.* Recent Exploration in the Kindabwe Coal Area and Its Bearing on the Correlation of the Coal Measures of Northern and Southern Rhodesia. R. TAVENER-SMITH, *Trans. Geol. Soc. S. Africa*, Vol. LXI, 1958.

†Economic, Africa : *Tin, South-West.* Note on Some Cassiterite-Bearing Pegmatites near Brandberg, South-West Africa. J. G. DENNIS, *Econ. Geol.*, Sept.–Oct., 1959.

Economic, Australia : *Pyrite, South.* Pyrite Investigations at Nairne. R. F. LA GANZA, *Econ. Geol.*, Aug., 1959.

Economic, United States : *Limestone, California.* Limestone and Dolomite in the Northern Gabilan Range, California. O. E. BOWEN, C. H. GRAY, Calif. Div. Mines Spec. Report 56.

Economic, United States : *Uranium, Alaska.* Geology of the Ross-Adams Uranium-Thorium Deposit, Alaska. E. M. MACKEVETT, *Min. Engg.*, Sept., 1959.

Permafrost, United States : *Research, Study.* Periodic Heat Flow in a Stratified Medium with Application to Permafrost Problems. A. H. LACHENBRUCH, *U.S. Geol. Surv. Bull.* 1083—A.

Sulphur, Egypt : *Study, Ras Gemsa.* Formation of Sulphur by Reduction of Anhydrite at Ras Gemsa, Egypt. G. A. SCHNELLMANN, *Econ. Geol.*, Aug., 1959.

†Survey, Geophysics : *Electromagnetic, Sweden.* Scandinavian Electromagnetic Prospecting Techniques. F. C. FRISCHKNECHT, *Min. Engg.*, Sept., 1959.

Survey, Geophysics : *Resistivity, United States.* Directional Resistivity Measurements in Exploration for Uranium Deposits on the Colorado Plateau. G. V. KELLER, *U.S. Geol. Surv. Bull.* 1083—B.

Metallurgy

Ash, Coal : *Determination, Continuous.* "Cendrex" Apparatus for the Continuous Determination of the Ash Content of Coal. H. DIJKSTRA, B. S. SCISWERDA, *Coll. Engg.*, Oct., 1959.

Hydrometallurgy, Leaching : *Exchange, Ion.* Moab Turns to Alkaline Leach R.I.P. *Engg. Min. J.*, Oct., 1959.

Ore, Iron : *Plant, Preparation.* Stanton Ore Preparation Plant. *Iron, Coal Tr. Rev.*, Oct 16, 1959.

Machines, Materials

Alloys, Light : *Hazard, Friction.* Frictional Sparks from Light Alloys. A. LATIN, *Coll. Engg.*, Sept., 1959.

Belts, Conveyor : *Care, Maintenance.* How To Avoid Conveyor Belt Failure. N. J. CYPHERS, *Engg. Min. J.*, Oct., 1959.

Belts, Conveyor : *Operation, Standard.* National Safety Council Recommends Safe Steps for Conveyor Belt Operation. *Engg. Min. J.*, Oct., 1959.

Cement, Grouting : *Additive, Chemical.* Chemical Additive Cuts Grouting Costs. *Engg. Min. J.*, Oct., 1959.

Conveyor, Cable-Belt : *Description, Uses.* The Cable-Belt Conveyor. C. A. S. MOORE, *J. Leeds Univ. Min. Soc.*, Vol. 35, 1959.

Explosives, Research : *Studies, Granite.* Comparative Studies of Explosives in Granite. T. C. AITCHISON, W. E. TOURNAY, *Rep. Inv. U.S. Bur. Min.* 5509.

Feeders, Ore : *Choice, Design.* Choosing the Right Tool for Ore Feed. W. E. MILLIGAN, *Engg. Min. J.*, Oct., 1959.

Locomotives, Mine : *Review, Uses.* Mine Locomotives. T. E. GREEN, *J. Leeds Univ. Min. Soc.*, Vol. 35, 1959.

Machinery, Underground : *Development, Study.* Progressive Development of Mining Machinery Through Usage Underground. A. YORKE SAVILLE, *Trans. Instn Min. Eng.*, Oct., 1959.

Winders, Mine : *Drive, Development.* Winder Drive Development. R. GARDINER, *Iron, Coal Tr. Rev.*, Nov. 6, 1959.

Mining

Blasting, Research : *Energy, Strain.* Strain Energy in Explosion-Generated Strain Pulses. D. E. FOGELSON and others, *Rep. Inv. U.S. Bur. Min.* 5514.

Breaking, Blasting : *Techniques, Coal.* Blasting Techniques in Mines: Application of Recent Developments. R. F. MCCORMICK, E. J. PARTINGTON, *Iron, Coal Tr. Rev.*, Nov. 6, 1959.

General, Canada : *Copper, Quebec.* Mining at Gaspé Copper. W. G. BRISSENDEN, *Min. Engg.*, Sept., 1959.

†**General, Canada :** *Copper, Quebec.* The Mining Engineering Department at Gaspé Copper Mines, Ltd. J. B. WATTS, *Canad. Min. Metall. Bull.*, Sept., 1959.

***General, South Africa :** *Sinking, Record.* The Sinking Record at Vaal Reefs. L. A. WASPE, THE MINING MAGAZINE, Nov., 1959.

Handling, Belt : *Lay-Outs, Modern.* Belt Conveyors in Modern Layouts. H. STREET, *J. Leeds Univ. Min. Soc.*, Vol. No. 35, 1959.

Handling, Conveyor : *Use, Chain.* Some Aspects of Chain Conveying. D. HOLDING, *J. Leeds Univ. Min. Soc.*, Vol. No. 35, 1959.

Hazards, Fire : *Coal, Industrial.* Firefighting Facilities at Coal Mines Compared with Those at Other Industrial Plants. R. W. STAHL, *Inform. Circ. U.S. Bur. Min.* 7931.

Hazards, Fire : *Mines, Coal.* Control of Fires in Inactive Coal Deposits in Western United States. T. R. JOLLEY, H. W. RUSSELL, *Inform. Circ. U.S. Bur. Min.* 7932.

Hygiene, Silicosis : *Suppression, Dust.* Automatic Control Devices for Conveyor Belt Sprays. *N.C.B. Inform. Bull.* 59/213.

***Metal, Review :** *Progress, Survey.* A Half Century of Progress in Metal Mining. G. KEITH ALLEN, THE MINING MAGAZINE, Oct., Nov., 1959.

Output, Control : *Study, Use.* Production Control: Application in Mines. E. J. KIMMINS, *Iron, Coal Tr. Rev.*, Oct. 23, 1959.

Sinking, Shaft : *Diamond, South Africa.* Deepening of No. 1 Vertical Shaft at Premier (Transvaal) Diamond Mining Co., Ltd. D. BORCHERS, *Bull. Instn Min. Metall.*, Nov., 1959.

Sinking, Shaft : *Pre-Grouting, South Africa.* Pre-Grouting at No. 2D Shaft, President Brand Gold Mining. R. A. MUDD, *J. S. Afr. Inst. Min. Metall.*, Sept., 1959.

Support, Roadhead : *Report, Coal.* Support at Roadheads. *N.C.B. Inform. Bull.* No. 59/212.

Temperatures, Rock : *Determination, United Kingdom.* Techniques for the Underground Measurement of Virgin Strata Temperatures with Ample Determinations in North Staffordshire. A. D. HARRIS, C. JONES, *Coll. Engg.*, Sept., 1959.

Winding, Multi-Rope : *Coal, United Kingdom.* Multi-Rope Winding at Rufford Colliery. *Coll. Engg.*, Sept., 1959.

Ore-Dressing

Dams, Tailing : *Use, Cyclones.* Mobile Cyclones Build Tailing Dam. B. J. HOLIDAY, R. WILKS, *Engg. Min. J.*, Oct., 1959.

Flotation, Research : *Collectors, Iron.* Effects of Structure and Unsaturation of Collector on Soap Flotation of Iron Ores. S. R. B. COOKE and others, *Min. Engg.*, Sept., 1959.

Flotation, Research : *Concentration, Collector.* Relationship Between Particle Size and Collector Concentration. A. J. ROBINSON, *Bull. Instn Min. Metall.*, Nov., 1959.

General, Eire : *Sulphides, Avoca.* The Avoca Enterprise—IV. I. R. COREY, *Mine, Quarry Engg.*, Oct., 1959.

Handling, Concentrates : *Taconite, United States.* Pneumatic Conveying Solves Taconite Processing Problems. *Engg. Min. J.*, Oct., 1959.

Plant, Design : *Economies, Study.* Economy Through Design. R. S. LINNEY, *Min. Engg.*, Sept., 1959.

Solids, Pumping : *Progress, Review.* Pumping Solids Through a Pipe-Line. J. NARDI, *Min. Engg.*, Sept., 1959.